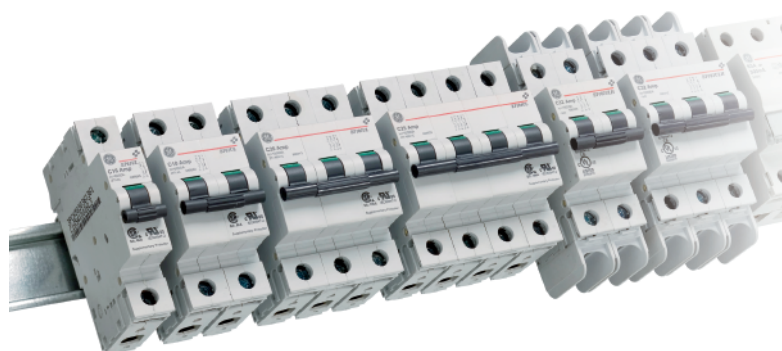


E2000 Miniature Circuit Breakers

Application Flexibility

- Dual AC & DC Ratings
- 6 kAIC & 10 kAIC Interruption Ratings @ 480Y/277 Vac
- C & D Trip Characteristics from 0.5 to 63 A
- B Trip Characteristics from 5 to 63 A
- Standard North American 5, 15, 30 & 60 A Ratings
- Left & Right Side Accessory Mounting – Up to 4 per Side
- 35mm DIN-rail Mounting
- UL Recognized & CSA Approved



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E2000 Miniature Circuit Breakers

Short Circuit Capacity

Per UL 1077 (File E151139) & CSA 22.2 (No. 235-1989)

EP60

Poles	Max. Voltage Rating		Short Circuit Rating kAIC RMS Symmetrical				kAIC DC	
	AC	DC	120	120/ 240	277	480Y/ 277	50	110
1	277	50	10	–	6	–	10	–
2	480Y/277	110	10	10	6	–	–	10
3, 4	480Y/277	110	10	10	6	10	–	–

EP100

Poles	Max. Voltage Rating		Short Circuit Rating kAIC RMS Symmetrical				kAIC DC	
	AC	DC	120	120/ 240	277	480Y/ 277	50	110
1	277	50	10	–	10	–	10	–
2	480Y/277	110	10	10	10	–	–	10
3, 4	480Y/277	110	10	10	10	10	–	–

EP100UC (not UL or CSA approved)

AC acc. to IEC 60898-2

Poles	V	Icn/Ics (kA)
1	125 DC	10
	220 DC	6
	230/400 AC	6
2	250 DC	10
	440 DC	6
	400 AC	6

AC acc. to IEC 60947-2

Poles	V	Icn/Ics (kA)
1, 2	240 AC	10

EP100ULH

AC acc. to UL 489

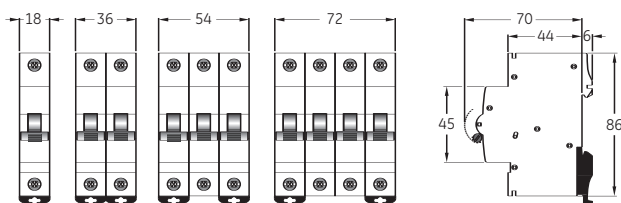
Poles	V	Icc (kA)
1	120	10
2	240	10

AC acc. to IEC 60947-2

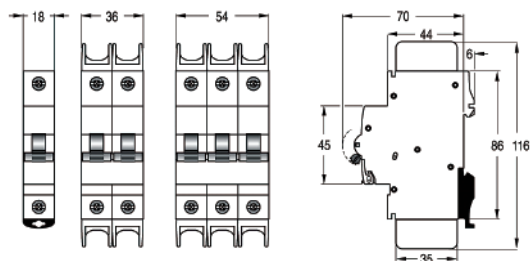
Poles	V	Icu (kA)*
1	127	30
	240	15
	415	4
2	127	40
2, 3	240	30

Dimensions

EP60, EP100, EP100UC

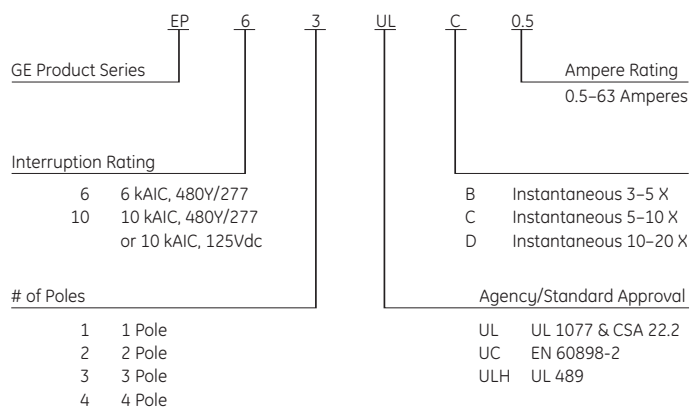


EP100ULH



Catalog Number Structure

For use in interpreting catalog numbers only.
Do not use to construct catalog numbers.



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Electrical Distribution

Record Plus™ FG 600

Current Limiting Molded Case Circuit Breakers

Catalog/Selection Guide



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FG 600 Amp Frame Overview



- 1 Breaker Frame Rating
- 2 Product Description
- 3 Standards & Markings
- 4 Interrupting Ratings
- 5 Lug Data & Torque Info
- 6 Catalog Number
- 7 Push to Trip

Main Standards

- UL 489
- IEC 947 and associated EN Sections

Other Global Standards

- BS
- CE
- CEI
- JIS
- UNE
- VDE

FG Breaker Markings

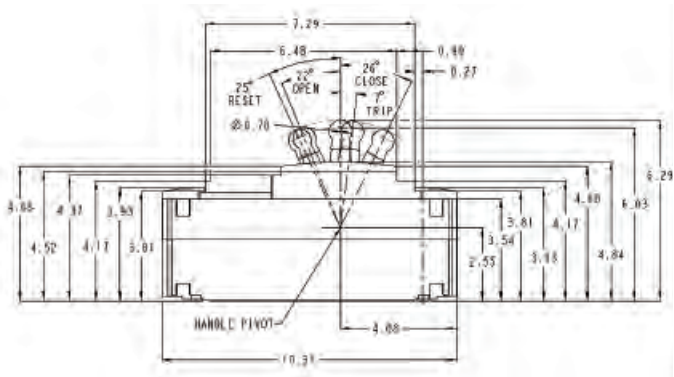
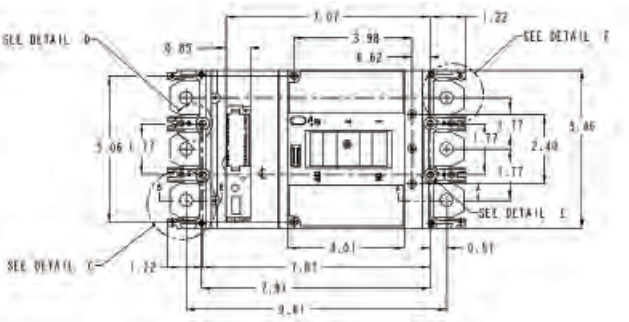
	UL file E-11592
HACR	250 to 600A
Cu/Al 60/75°C	250 to 600A
Current Limiting	250 to 600A

Not suitable for reverse feed.

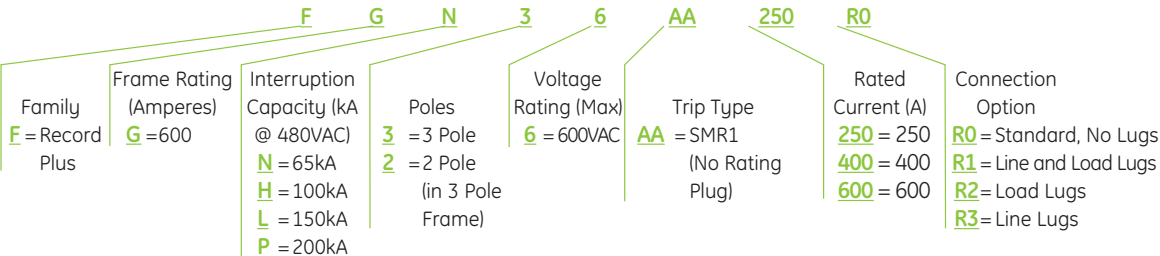
Interrupting Ratings

Ampere Rating	Maximum Voltage	Type	Poles	UL Listed Interrupting Rating rms Symmetrical Amperes (Thousands) AC Voltage			EN 60947-2 Interrupting Rating rms Symmetrical Amperes (Thousands)		
				240	480	600	240	400-415	690
250-600A	600 Vac	FGN	2	150	65	25	N/A	N/A	N/A
			3	150	65	25	85	50	10
		FGH	2	200	100	35	N/A	N/A	N/A
			3	200	100	35	100	80	22
		FGL	2	200	150	42	N/A	N/A	N/A
			3	200	150	42	200	150	40
		FGP	2	200	200	65	N/A	N/A	N/A
			3	200	200	65	N/A	N/A	N/A

Dimensions



Catalog Number Structure



Internal Accessories

FG Rating Plugs

CT Rating	Rated Current	Catalog Number	Trip Curve
250A	125A	FGRP3K0125	DES-042
	150A	FGRP3K0150	DES-043
	175A	FGRP3K0175	DES-044
	200A	FGRP3K0200	DES-045
	225A	FGRP3K0225	DES-046
	250A	FGRP3K0250	DES-047
400A	175A	FGRP3L0175	DES-048
	200A	FGRP3L0200	DES-049
	225A	FGRP3L0225	DES-050
	250A	FGRP3L0250	DES-051
	300A	FGRP3L0300	DES-052
	350A	FGRP3L0350	DES-053
	400A	FGRP3L0400	DES-054
600A	300A	FGRP3M0300	DES-055
	350A	FGRP3M0350	DES-056
	400A	FGRP3M0400	DES-057
	450A	FGRP3M0450	DES-058
	500A	FGRP3M0500	DES-059
	600A	FGRP3M0600	DES-060

Shunt Trip & Undervoltage Release

		Shunt Trip	Undervoltage Release
Vac	Vdc	Catalog Numbers	
-	12	FASHTBW	n/a
24	24	FASHTDW	FAUVRDW
48	48	FASHTFW	FAUVRFW
110 - 130	110 - 125	FASHTJW	FAUVRJW
120	-	FASHTKW	FAUVRKW
220 - 240	250	FASHTNW	FAUVRNW
277	-	FASHT7W	FAUVR7W
400 - 480	-	FASHTUW	FAUVRUW

UL Listed for field installation. Accessories are prewired from the factory with 36 inch long leads (#18 AWG). Shunt trip wire leads are black and UVR wire leads are blue.

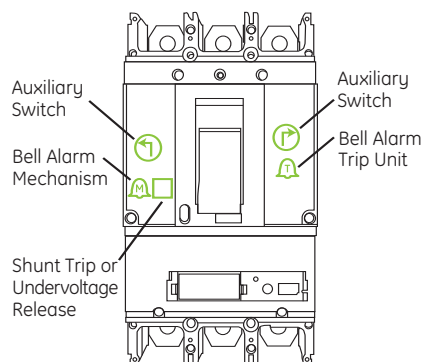
Bell Alarm & Auxiliary Switches

Bell Alarm Mechanisms	Bell Alarm Trip Units	Auxiliary Switches		Contact Configuration	Contacts	Contact Rating	Wire Leads
Catalog Numbers				1 NO (Form A)	Standard	5A @ 277Vac 0.3A @ 125Vdc	#16 AWG
FABAM10W	FABAT10W	FAS10LW	FAS10RW				
FABAM01W	FABAT01W	FAS01LW	FAS01RW	1 NC (Form B)	Standard	1A @ 30Vac/dc	#18 AWG
FABAM11W	—	FAS11LW	FAS11RW	1 NO/NC (Form C)	Standard		
FABAM11GW	—	FAS11LGW	FAS11RGW	1 NO/NC (Form C)	Gold plated		

UL Listed for field installation. Accessories are prewired from the factory with 36 inch long leads. Reference instruction sheet DEH-40324 for wire lead colors.

Internal Accessory Mounting Locations & Limitations

Accessory	Mounting Pocket Location	Maximum Quantity
Shunt Trip or Under Voltage Release		1
Aux. Switch - Left Mount		3
Aux. Switch - Right Mount		2
Bell Alarm Mechanism		1
Bell Alarm Trip Unit		1



External Accessories

Padlock Device

Description	Catalog Number
Padlock, EUSERC Toggle	FG1PE

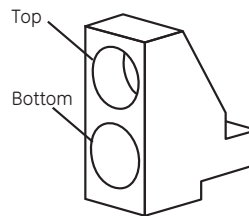
Lug Kits

Lugs are tin-plated aluminum

Poles/Lugs	Location	Wire Type	Torque		Strip Length		Catalog Number
			Wire-Lug	Lug-Strap	Top	Bottom	
2	Top	#8-400kcmil Cu, #6-500kcmil Al	#8-#4 AWG Cu/Al 275 lb-in (31 N-m)	200 lb-in (23 N-m)	7/8"	1 5/8"	FCALK218H
	Bottom	#2/0-600kcmil Cu/Al	#3 AWG-600kcmil Cu/Al 375 lb-in (42 N-m)				
3	Top	#8-400kcmil Cu, #6-500kcmil Al	#8-#4 AWG Cu/Al 275 lb-in (31 N-m)	200 lb-in (23 N-m)	7/8"	1 5/8"	FCALK318H
	Bottom	#2/0-600kcmil Cu/Al	#3 AWG-600kcmil Cu/Al 375 lb-in (42 N-m)				

Panelboard Mounting Kits

Panelboard	Poles	Catalog Number	
		Double Branch	Single Branch
Spectra Series Plug-in	2	AMC4FGB	AMC2FGM
	3	AMC6FGB	AMC3FGM
Spectra Series Bolt-on	2	AMCB4FGB	AMCB2FGM
	3	AMCB6FGB	AMCB3FGM



FCALK218H/FCALK318H

Other Accessories

Accessory	Catalog Number
Rating Plug Removal Tool	FAR
Breaker External Test Kit	FAT
Lug Cover Kit	FG1BCK
Replacement Trip Unit Shield	FG1TUSHLD
Replacement Handle Extension	FGHDLXT
Hardware Kit (Tapped Holes)	FGMSK1
Hardware Kit (Through Holes)	FGMSK2

Publications & References

Available for download from www.geelectrical.com/publibrary

FG Breaker

Installation Instructions DEH-41177

FG Breaker Accessories

Bell Alarm & Aux. Switch DEH-40324
 Shunt Trip & UVR DEH-40259
 Padlock Device DEH-41031
 Lug Kits DEH-40404
 Auxiliary Contacts DEH-40261

Panelboards

Spectra Power Panel - Plug-in Kits - Single DEH-40420
 Spectra Power Panel - Plug-in Kits - Double DEH-40419
 Spectra Power Panel - Bolt-on Kits - Single DEH-40426
 Spectra Power Panel - Bolt-on Kits - Double DEH-41047

Series Ratings

DET-008

Trip Curves

(See FG Rating Plugs Table for Rating Plug Trip Curves)

Peak Current Curve DES-040
 Peak I²t Curve DES-041

Data are subject to change without notice. Should further information be desired, or should particular problems arise that are not sufficiently covered here for the purchaser's purposes, the matter should be referred to the General Electric Company.

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Gerapid High Speed DC Circuit Breakers

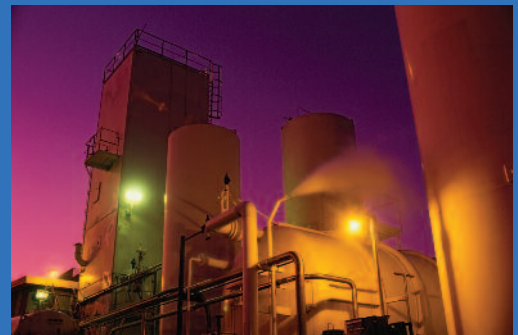
On the move



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Gerapid High Speed DC Circuit Breakers

To stay up and running today, you need equipment that delivers both unwavering reliability and the technology 21st century systems require. Gerapid satisfies that need. Around the world, in all conditions, they keep people and industry on the move.



These single-pole breakers are suitable for protection of mains and semiconductors (converters/rectifiers) in a variety of railway and industrial applications. The feeder and rectifier breakers come with operating currents up to 8,000ADC and operating voltages up to 3,600VDC. Their very high interruption capacity combines with current limiting characteristic as shown in Tables 1-3.

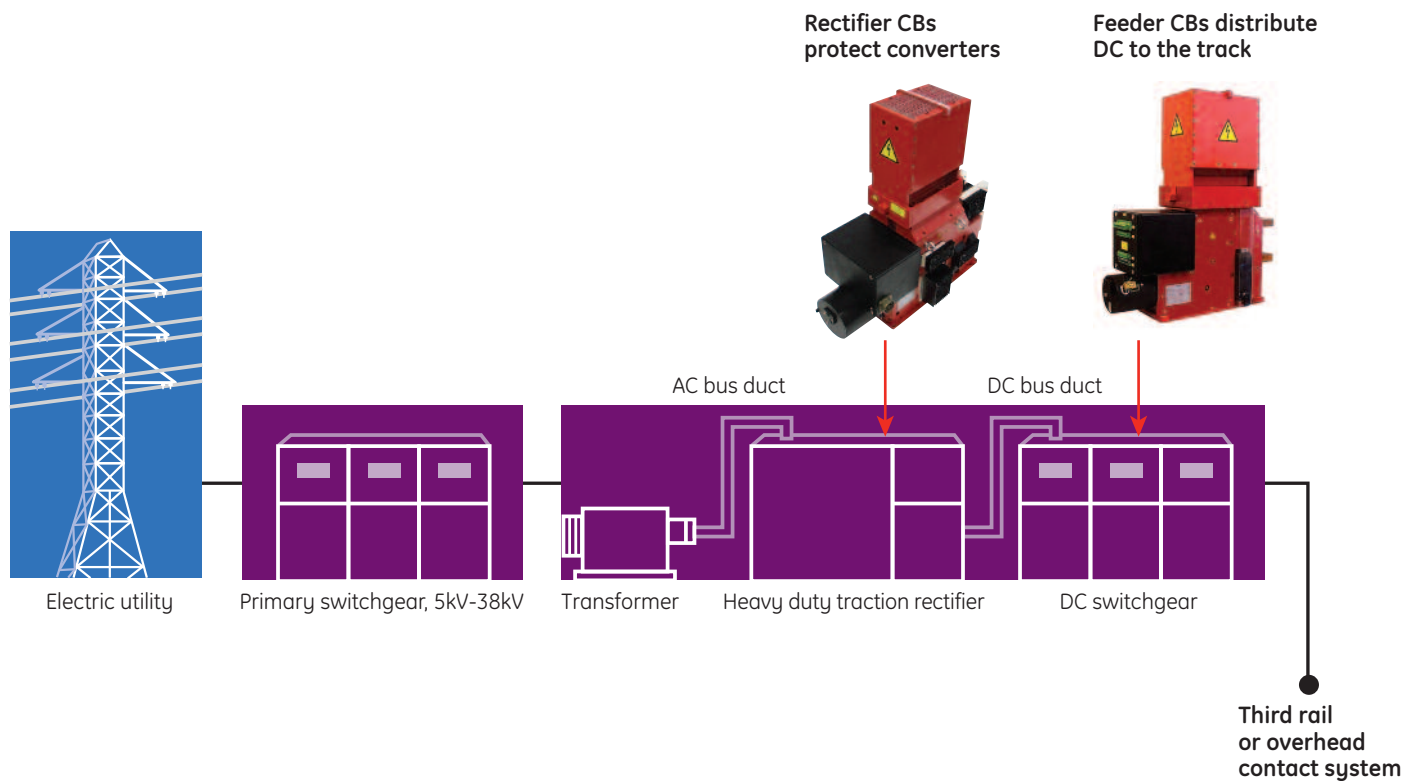
Innovative materials, superior circuit breaking capacity and outstanding dielectric performance ensure service continuity and protection during adverse system events. The technology and quality of these circuit breakers produce high reliability, extended maintenance intervals and uncomplicated serviceability for all fixed installations.

A wide range of fully accessorized rectifier and feeder circuit breakers are available. All comply with IEC 947-2 and ANSI C37.14.

Typical applications include:

- traction power (light rail transit, tram, subway, maglev, etc.)
- industrial plant protection (electrolysis plants, iron and steel mills, etc.)
- mining
- chemical, petrochemical
- power generation
- research/experimental (e.g., physics, particle accelerator protection)

Typical Traction Electric Power System



Circuit Breaker Features and Accessories

- Insulated side plates with insulated toggle for setting over current trip (OCT) for feeder breakers
- Mechanical forced tripping
- Electrodynamic trip device (with or without capacitor and charging unit)
- Shunt trip
- No-voltage release
- Auxiliary contacts
- Different auxiliary contacts for signaling (optional)
- Main terminal configurations variable
- Plug connectors for auxiliary circuits (optional)
- Hand lever for manual actuation from front (for maintenance purposes only)
- Position indication (optional)
- Internal power supply with a wide range of supply voltage options
- Integrated current measurement unit (SEL) (optional)
- Rectifier breaker mechanical counter

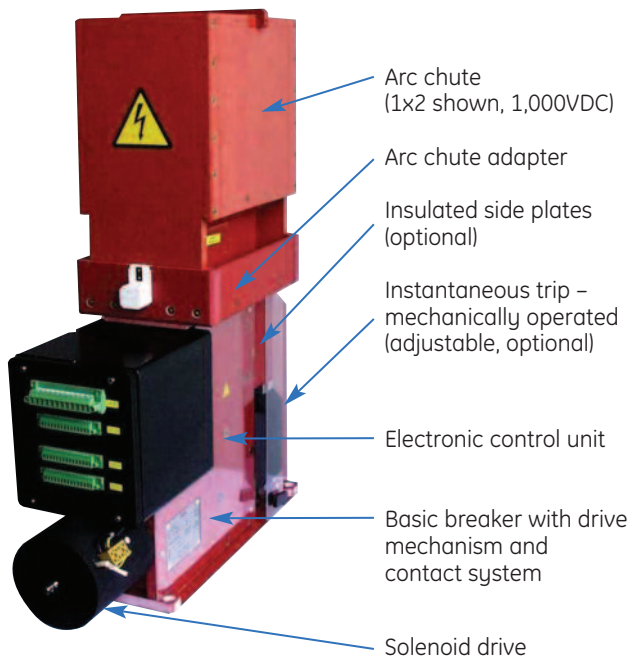
Key Benefits

- Standard dimensions from 2,600A to 6,000A (feeder models GER2607 – GER8007)
- Operating voltages from 1,000 to 3,600VDC
- Mining and traction compliant (ANSI C37.14, IEC 947-2, EN 50123-2)
- High speed OPEN/TRIP (opening delay <3ms)
- Direct acting instantaneous and adjustable trip unit works without imported energy and is available as bidirectional symmetrical (for line feeder) or unidirectional (for rectifier breaker)
- High speed CLOSE (approximately 150 ms)
- Solenoid drive (integral control unit, mechanically latched, no auxiliary power required to keep contacts closed)
- 2-stage contact system minimizes contact wear
- Compact, enclosed construction
- Modular, serviceable design
- Easily accessible control and auxiliary connections
- Fixed and draw-out versions
- Extensive accessories/options

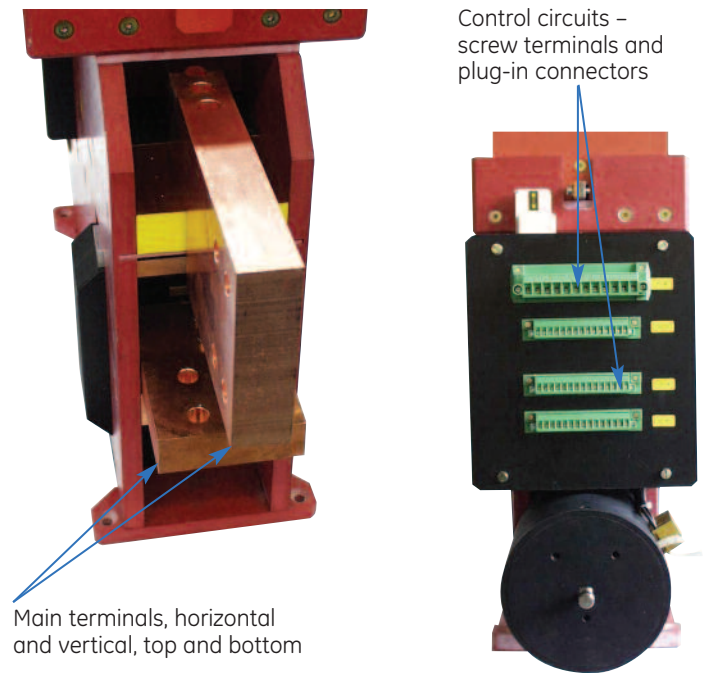
General Information

Rated Temperature	-5° to 40°C ambient (55°C with reduced ratings)
Relative Humidity	90% @ T<20°C; RH=130-2*T @ T>20 °C
Altitude	-120m to 2000m above sea level

Gerapid Breaker Modules



Power and Control Connections



Type SEL Current Measurement System (optional on 2607 and 4207)

- Current measurement at the breaker
- Factory-equipped or field-installable
- No additional space required or breaker modifications
- Ranges 6kA and 12kA
- To 4,000VDC
- Signal output via 3 interfaces
 - 4...20mA
 - +/- 20mA
 - +/- 10V
- Watchdog function standard

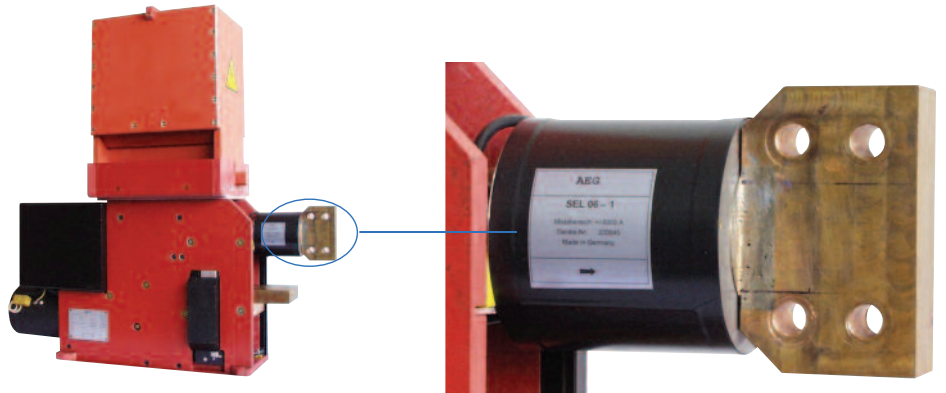


Figure 1.
Models 2607 - 6007 Feeder CBs,
1X4 Arc Chute, 2,000VDC

Dimensions in mm

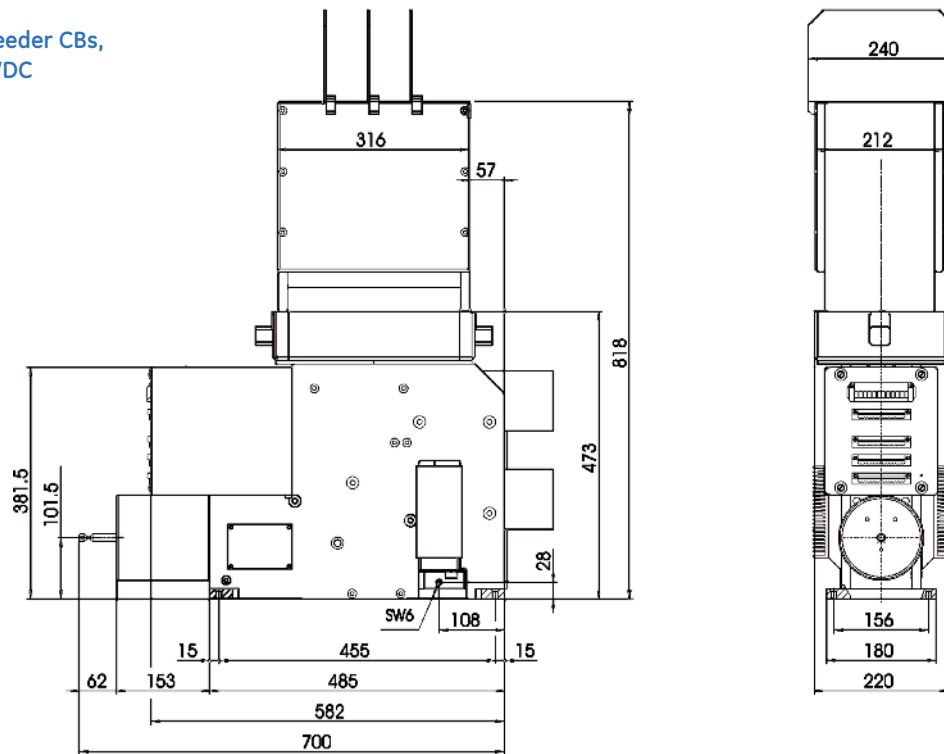


Figure 1A.
Models 2607 - 6007 Feeder CBs,
2X4 Arc Chute, 3,600VDC

Dimensions in mm

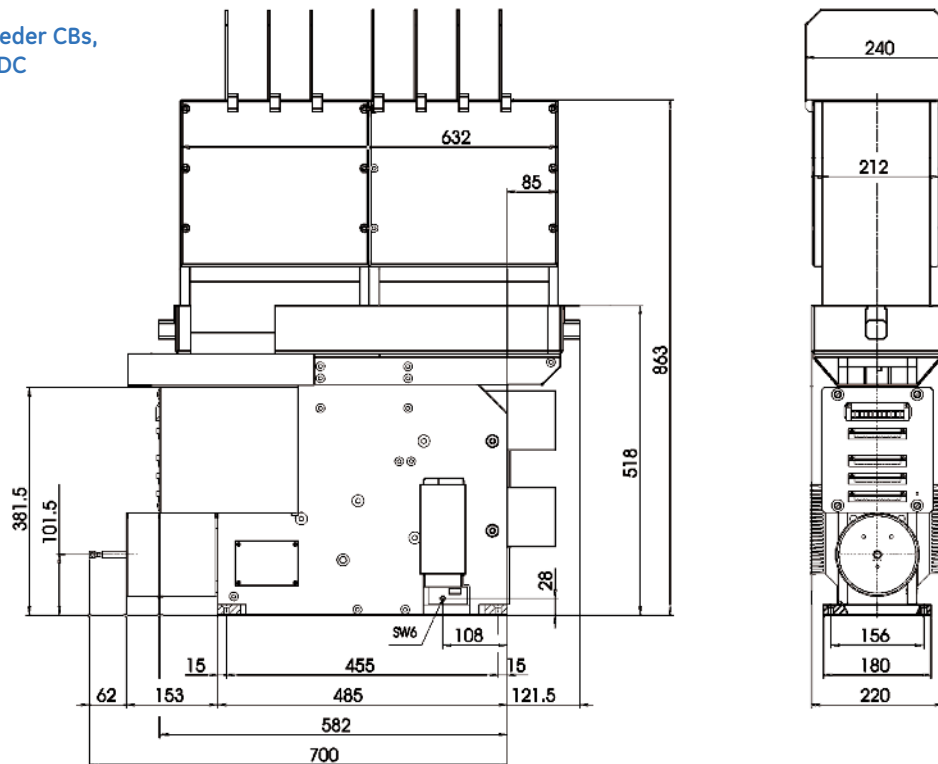


Figure 2.
Gerapid 8007 Feeder CBs,
1X4 Arc Chute, 2,000VDC

Dimensions in mm

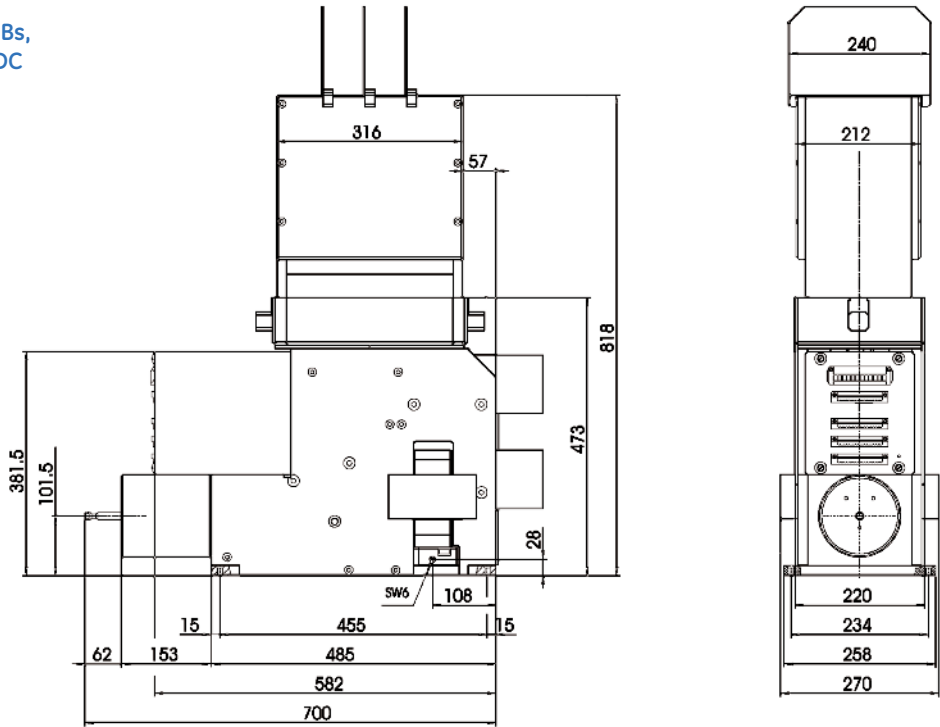
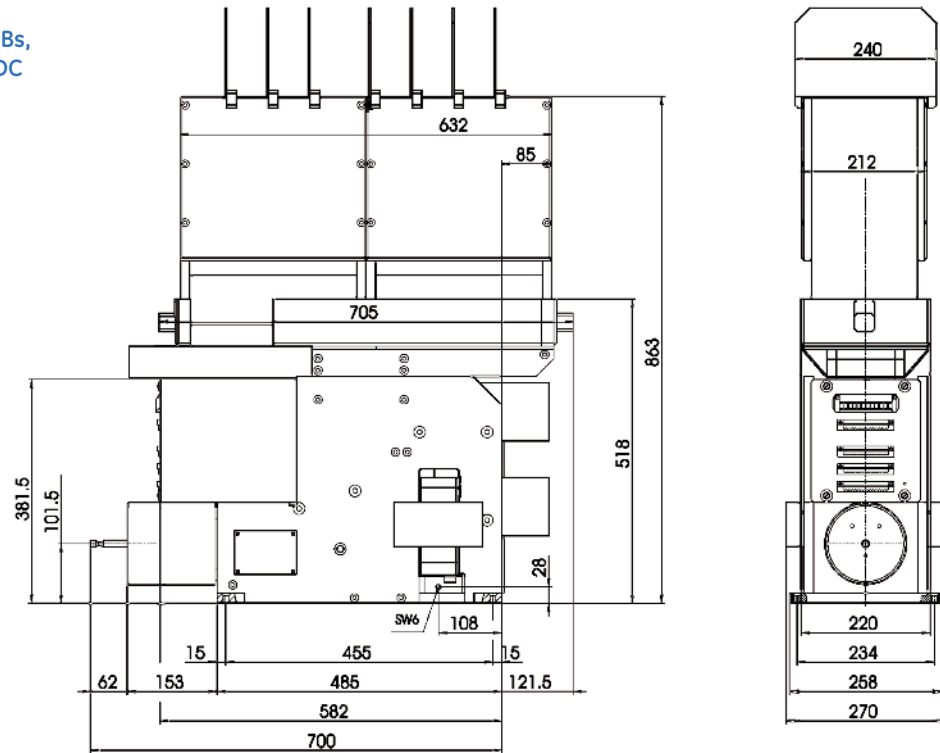
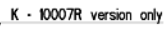


Figure 2A.
Gerapid 8007 Feeder CBs,
2X4 Arc Chute, 3,600VDC

Dimensions in mm



Dimensions in mm



Technical Data

Table 1.
Gerapid FCB

Specification	Gerapid Breaker Type																
	2607					4607					6007					8007	
Arc chute type	1X2	1X4	2X2	2X3	2X4	1X2	1X4	2X2	2X3	2X4	1X2	1X4	2X2	2X3	2X4	1X2	2X2
Conventional thermal current I _{th} [A] (IEC/EN)	2600					4200					6000					8000	
Rated current [A] (ANSI/IEEE C37.14)	2600					4150					*					6000	
Rated voltage U _{Ne} [V]	1000	2000	2000	3000	3600	1000	2000	2000	3000	3600	1000	2000	2000	3000	3600	1000	2000
Rated voltage [V] (ANSI/IEEE C37.14)	800					800		1600								800	
Rated insulation voltage U _i [V]	2000	2000	2000	3000	4000	2000	2000	2000	3000	4000	1000	2000	2000	3000	4000	1000	2000
Short time current 120 min [A]	3150					5000					7200					9600	
Short time current 2 min [A]	5200					8500					12000					16000	
Short time current 20 sec [A]	7800					12600					18000					24000	
Impulse withstand voltage 1,2/50 μs U _i [kV] according to EN 50124-1:1997	18	18	18	30	30	18	18	18	30	30	12	18	18	30	*	12	18
Power frequency withstand voltage 50 Hz U _o [kVeff] according to EN 50124-1:1997	10	10	10	15	15	10	10	10	15	15	7	10	10	15	*	7	10
Rated short circuit making capacity I _{Nss} [kA]	70	50	100	50	42	70	50	100	50	42	70	50	80	50	*	70	*
Rated short circuit breaking capacity I _{Nss} [kA] according to EN 50123-2	50	30	71	35	30	50	30	71	35	30	50	35	56	35	*	50	50
Rated service short circuit breaking current I _{cs} [kA] according to IEC 60947-2	60	40	50	40	40	60	40	50	40	40	60	40	50	40	*	60	*
Short circuit current [kA] at U _{ne} = 800 VDC	200					200										200	*
Short circuit current [kA] at U _{ne} = 1600 VDC			*					100					*				*
Maximum short circuit current test [kA]	244	120	100		52	244	120	100		52	200					240	
Maximum arc voltage U _{arc} [kV]	2	4	4	5.6	7	2	4	4	5.6	7	2	4	4	5.6	7	2	4
Weight ca. [kg]	120	120	160	160	160	120	120	160	160	160	150	150	165	165	165	190	210

*Characteristic tests at customer request.

Table 2.
Gerapid 8007R & 10007R

Parameter	Reference	Gerapid 8007R		Gerapid 10007R	
Arc chute type	N/A	1x2	1x3	1x2	1x3
Rated continuous current [A]	ANSI C37.14 p.5.3	6000	6000	8000	8000
2 hours current [A]	N/A	7200	7200	9600	9600
2 minutes current [A]	N/A	12000	12000	16000	16000
20 seconds current [A]	N/A	18000	18000	24000	24000
Rated short-time current (250ms) [kA]	ANSI C37.14 p.5.5	90 (149 peak)	60 (100 peak)	90 (149 peak)	60 (100 peak)
Rated maximum voltage [V]	ANSI C37.14 p.5.2	800	1200	800	1200
Rated insulation voltage - U _{Nm} [V]	EN 50124-1 p.1.3.2.4	2000	2000	2000	2000
Rated impulse voltage - U _{Ni} [kV]	EN 50124-1 p.1.3.2.7	18 [1,2/50μs]	18 [1,2/50μs]	18 [1,2/50μs]	18 [1,2/50μs]
Power frequency voltage - U _o [kV]	EN 50124-1 a.B2.2	10 [1min. 50Hz]	10 [1min. 50Hz]	10 [1min. 50Hz]	10 [1min. 50Hz]
Mechanical endurance [cycles] ¹	N/A	10000	10000	10000	10000
Rated short circuit peak / sustained [kA / kA] ^{2,3}	ANSI C37.14 p.5.4	200 / 120	132 / 80	200 / 120	132 / 80
Short-circuit characteristic	Tests a,b,c,d acc. ANSI C37.14 annex A	High-speed	High-speed	High-speed	High-speed
Maximum arc voltage [V]	N/A	2500	2500	2500	2500
Mass ca.	N/A	220 kg	220 kg	220 kg	220 kg

1 10.000 cycles without parts replacement. Inspection after 5.000 cycles. Max. 5.000 cycles by means of ED impulse coil or POCT release.

2 Tested for high and low frequency impedance bonds.

3 Trip by means of POCT (direct-acting, instantaneous, electromechanical and polarized OC release) or by means of ED impulse coil with no intentional delay.

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DEA-379A (02/10)
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GE
Electrical Distribution

EntelliGuard® G Circuit Breaker

Application Guide



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EntelliGuard® G Power Circuit Breaker

Section 1. Introduction

EntelliGuard G circuit breakers are the newest line of low voltage power circuit breakers (LVPCBs) evolved from the exceptional designs and practices of GE legacy breakers. EntelliGuard G breakers offer a truly global product platform that meets industry standards throughout the Americas, Europe and Asia (ANSI, UL, CSA, IEC, Lloyds Register of Shipping, etc.).

Breakers are available to OEMs in 3- and 4-pole designs from 400A to 6400A (IEC) with fault interruption ratings up to 150kA. New, state-of-the-art EntelliGuard Trip Units enable the breakers with advanced technology that provides system protection, local and remote monitoring, relaying and communications. EntelliGuard Trip Units may be supplied with either Modbus or Profibus communications protocols. The breaker-trip unit system delivers superior circuit protection without compromising selectivity or arc flash protection. The EntelliGuard system is yet another evolution of GE's core competencies in reliable electric power distribution, circuit protection and arc flash protection.

EntelliGuard G 3-pole breakers are the standard in GE AKD-20 Low Voltage Switchgear. The breakers are suitable for 280Vac, 480Vac and 600Vac applications, and they provide advanced circuit protection, limit arc fault energy and preserve system coordination without sacrificing any of these critical functions (Table 1.1).

Table 1.1. Device Standards and References (See Section 8 for Details)

ANSI® Certified	UL® Listed	IEC® Rated	IEC® Extreme Atmospheric Conditions
Low-Voltage	Insulated Case	Circuit Breaker	IEC 68-2-1: Dry cold at -55°C
Power Circuit	Circuit Breaker	IEC 60947-1	IEC 68-2-2: Dry heat at 85°C
Breaker	UL 489	IEC 60947-2	IEC 68-2-30: Damp heat (temp. 55°C, rel. humidity 95%)
C37.13	NEMA AB1	IEC 60947-3	IEC 68-2-52 Level 2: salt mist
C37.16	CSA 22.2 NO 5.1		
C37.17			
C37.20			
C37.50			
UL 1066			
NEMA SG3&5			

EntelliGuard G devices are available in all standard, 100% rated, ANSI, UL and IEC ratings in both fixed and draw-out designs. Standard devices are also offered in 4 pole designs. No compromise (e.g., derating) is necessary in the system protection scheme as the EntelliGuard G Neutral poles are fully rated. Front and rear access connections are available, and all configurations can be manually or electrically operated with multiple and redundant accessories (optional) (Table 1.2).

Table 1.2. Device Ratings

Standard	Sensors Available		
	Envelope 1	Envelope 2	Envelope 3
ANSI/UL	400A - 2000A	400A - 3200A	3200A - 5000A
UL 489	400A - 2000A	400A - 3200A	3200A - 6000A
IEC	400A - 2000A	400A - 4000A	3200A - 6400A

EntelliGuard G short circuit and interrupting ratings are given in Tables 1.3 through 1.6.

Table 1.3. ANSI/UL1066 Ratings

Interrupting Rating Tier ANSI/UL1066 Devices, LVPCB					Envelope 1	Envelope 2		Envelope 3	
Type	240V	480V	600V	1/2S Withstand	400-2000	3200	400-3200	3200	4000-5000
N	65,000	65,000	65,000	65,000	X	X			
H	85,000	85,000	65,000	65,000	X				
E	85,000	85,000	85,000	85,000			X		
M	100,000	100,000	85,000	85,000			X		X
B	100,000	100,000	100,000	100,000				X	X
L	150,000	150,000	100,000	100,000				X	X

Table 1.4. UL489 Ratings

Interrupting Rating Tier UL489 Devices, ICCB					Envelope 1	Envelope 2		Envelope 3		
Type	240V	480V	600V	1/2S Withstand	400-2000	2500-3000	400-3000	3000	4000	5000-6000
N	65,000	65,000	65,000	42,000	X	X				
H	85,000	85,000	65,000	50,000	X	X				
M	100,000	100,000	85,000	65,000			X		X	X
L	150,000	150,000	100,000	85,000				X	X	X

Table 1.5. Non-Automatic Circuit Breaker – ANSI Version Ratings

Envelope	Type	Amps	Rated Interrupting Current	Rated Endurance		
				Minimum Mechanical Endurance	Minimum Electrical Endurance at 480V	Minimum Electrical Endurance at 600V
1	N	800	42	12,500	10,000	7,500
1	N	1600	42	12,500	10,000	7,500
1	N	2000	42	12,500	7,500	5,000
2	M	3200	65	5,000	5,000	5,000
3	B	4000	100	5,000	3,000	2,000
3	B	5000	100	5,000	2,000	1,500

- GE internal quality testing requirements exceeded 20,000 mechanical and electrical operations.

Table 1.6. Non-Automatic Circuit Breaker/Molded Case Switch – UL Version Ratings

Envelope	Type	Amps	Short Interrupting Current	Rated Endurance		
				Minimum Mechanical Endurance	Minimum Electrical Endurance at 480V	Minimum Electrical Endurance at 600V
1	N	800	42	12,500	10,000	7,500
1	N	1600	42	12,500	10,000	7,500
1	N	2000	42	12,500	7,500	5,000
2	M	3000	65	5,000	5,000	5,000
3	B	4000	100	5,000	3,000	2,000
3	B	5000	100	5,000	3,000	1,500
3	B	6000	100	5,000	1,500	1,000

- GE internal quality testing requirements exceeded 20,000 mechanical and electrical operations.

Altitudes and Closing Times

See Section 7, Tables 7.2 and 7.3.

Dimensions and Weights

See Section 7.

EntelliGuard® G Power Circuit Breaker Section 2. Features and Characteristics

Figure 2.1. EntelliGuard G Features and Characteristics

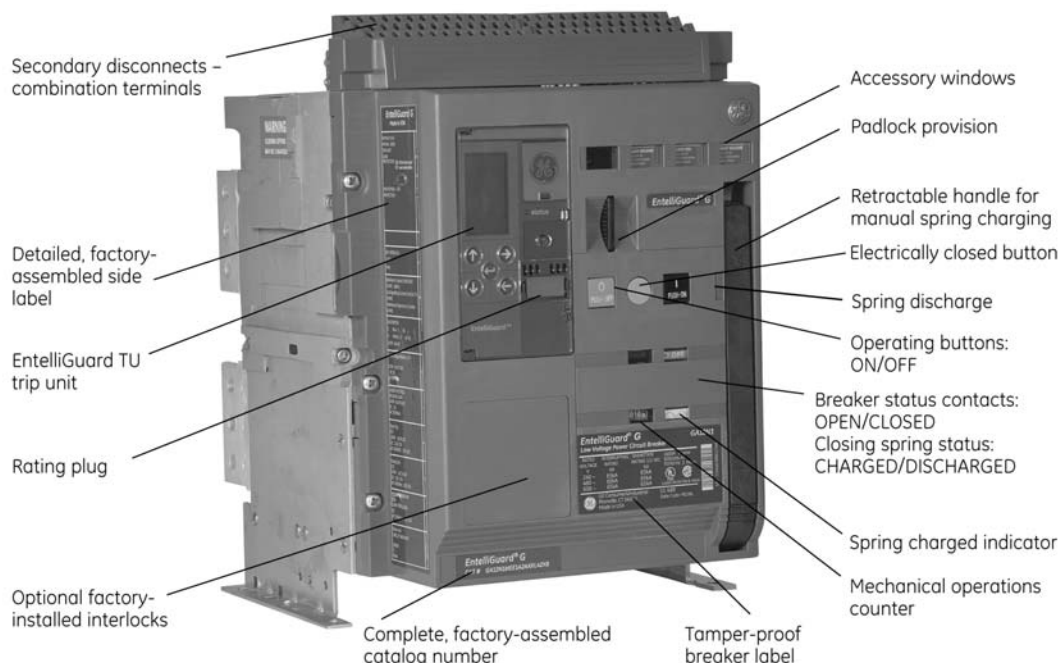


Figure 2.X. Label

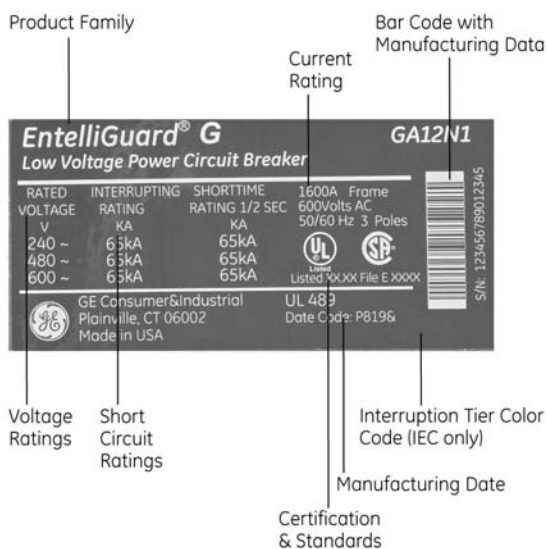
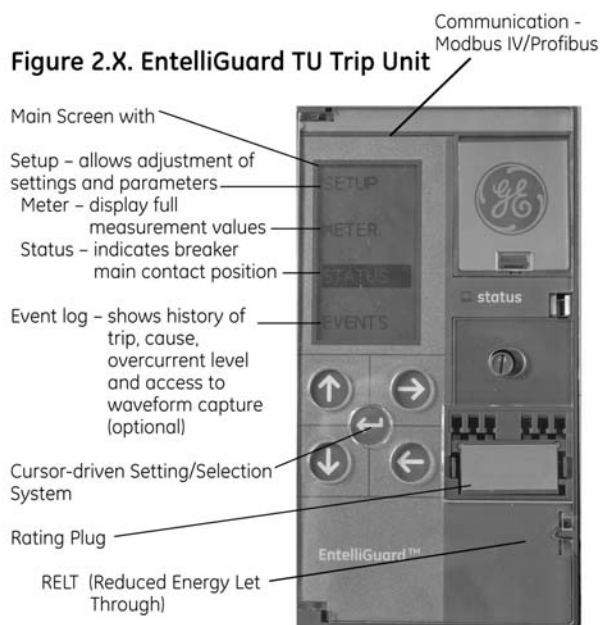


Figure 2.X. EntelliGuard TU Trip Unit



STANDARD AND OPTIONAL FEATURES

Short Time Rating

Short Circuit/High Interruption Rating

Thermal Performance

Reverse Feed

Two-Step Stored Energy Mechanism

Field Installable Trip Units and Accessories

Coils

Breaker/Main Contact Status

Motor Operator

Ready to Close Indicator

Up to 100kA for 1/2sec.

150kA at 600V, 100kA at 690V.

ANSI C37 and UL 489 designs are 100% rated up to 40°C when applied in recommended enclosure sizes. IEC 60947 versions are 100% rated in free air up to 50°C. IP31 enclosure/switchboard rating is based on size, recommended up to 50°C ambient with rear vertical bus connection (Table 2.1).

EntelliGuard G devices can be fed from top or bottom terminals.

EntelliGuard G operates via stored energy mechanisms that can be manually charged (MO) or electrically charged (EO) by the Spring Charging Motor. Closing time is less than five cycles. Closing and opening can be initiated remotely or via the front cover push buttons. An Open-Close-Open cycle is possible without recharging. The breaker operating mechanism is a trip-free mechanism and is furnished with an integrated anti-pumping system.

Field-installable accessories are common to all breaker envelopes and frames.

EntelliGuard G devices have provisions for four accessory operating coils. The four positions can be filled by the following four devices: one Close Coil (CC or CCC), one Shunt Trip Coil, one UVR (Under Voltage Release), and the fourth position can either be a Shunt Trip Coil or a UVR. The closing coil is a “one-shot” electronic closed circuit. Shunt trip (ST) coils are continuous rated. Under voltage relays (UVR) are available with a fixed time delay (50ms at down to 50% system voltage; 20ms below 50% system voltage). The time delay module (TDM) is available as a shipped-loose accessory for remote installation (in equipment). Optional status contact modules for the ST, CC and UVRs provide coil status (energize/de-energize) via the secondary disconnects and trip unit.

OPEN/CLOSED, ON/OFF indication is provided on the front cover.

Heavy duty, motor/gearbox unit; easily accessible

Provides visible indication/readiness for close operation.

Table 2.1. Sensors Available

Standard	Envelope 1	Envelope 2	Envelope 3
ANSI/UL	400 - 2000	400 - 3200	3200 - 5000
UL 489	400 - 2000	400 - 3000	3200 - 6000
IEC	400 - 2000	400 - 4000	3200 - 6400

Mounting Straps/Accessories

Kits are available to mount and connect fixed/stationary breakers.

Auxiliary Switches (Optional)

Four available designs:

- Power rated (3NO+3NC)
- Power rated (3NO+3NC) + low signal (Hi-Fi) (2NO+2NC)
- Power rated (8NO+8NC)
- Power rated (4NO+4NC) + low signal (Hi-Fi) (4NO+4NC)

Interlocks

Standard interlocks include:

- Drawout Breaker: prevents the breaker from being closed unless it is in the TEST or CONNECT positions
- Drawout Breaker/Main Contacts: prevents withdrawal/removal of the breaker unless the main contacts are OPEN. Access to the drawout mechanism racking screw is blocked when the breaker is CLOSED.
- Spring Discharge Interlock: Automatically discharges the closing springs when the breaker is moved from the TEST to the DISCONNECT position. This prevents withdrawing a breaker from the cubicle with the closing springs charged.

Breaker Status Indicators

Standard Indicators include:

- The breaker status indicator shows the condition of the main contacts (OPEN, CLOSED).
- The status of the closing springs is indicated as CHARGED or DISCHARGED.
- The draw-out position indicator displays whether the breaker is in the CONNECT, TEST or DISCONNECT position.
- The breaker also includes a switch that provides main contact status indication to the POWER LEADER™ Power Management System.
- The optional Reduced Energy Let-Through (RELT) is provided with an ON/OFF contact closure to positively indicate whether the RELT setting is enabled or not.

Rejection Feature

A factory-installed rejection feature prevents mismatching breakers and cassettes/substructures. This prevents (a) inserting a breaker with a lower interrupting rating into a higher rated cassette/substructure and (b) inserting a higher current rated breaker into a lower rated cassette/substructure.

Through-Door Racking	The breaker racking mechanism is accessible through the front door and permits safely disconnecting/withdrawing the circuit breaker without opening the door and exposing personnel to live parts during the process.
Padlocking Devices	The padlocking device is standard on breakers and allows up to three padlocks with 1/4" to 3/8" diameter shanks to secure the breaker in the OPEN/TRIP FREE position. A padlock provision on the front panel of the cassette/substructure permits locking the breaker in either the TEST or DISCONNECT position with up to three padlocks.
Key Interlock	Up to four optional key interlocks are available (Kirk, Ronis, Profalux, Castell). Switch gear applications utilize a Kirk key interlock mounted in the cassette. A maximum of two key interlocks may fit in the cassette.
Shutters	Optional lockable shutters are available (factory installed).
Carriage Position Switch	This optional cassette/substructure device permits local or remote indication of the circuit breaker status (CONNECTED, TEST, DISCONNECTED), 2NO/2NC single pole, double throw contacts are available for each position.
Lifting Truck	Optional lifting tool with separate slings is available for all breaker sizes.
IP Covers	Optional IP54 covers (protected against harmful amounts of dust and splashing water) are available for all breaker sizes.
Mechanical Counter	Provides local record of the cumulative number of complete breaker closing operations.
Cable Interlocks (OEM Applications Only)	Available for fixed and draw-out breakers, these units enable direct interlocking of EntelliGuard G circuit breakers.
Bell Alarm Contact	Available with or without a mechanical lockout feature, the bell alarm operates whenever the breaker trips due to a protective function (electrical fault).

EntelliGuard G Power Circuit Breaker Section 3. EntelliGuard TU Trip Unit System

Introduction

The EntelliGuard TU Trip Unit offers optimum circuit protection and optimum system reliability simultaneously with little or no compromise to either of these critical functions. Reliability and arc flash protection, in one package, at the same time, all the time.

EntelliGuard TU series trip units are available as the standard controller for new production EntelliGuard G ANSI/UL 1066, UL 489 and IEC circuit breakers. EntelliGuard TU designs are also available as direct, functional replacements for GE's PowerBreak, PowerBreak II, WavePro, AKR, and AK circuit breakers. EntelliGuard TU trip units are also available in kit form for many popular non-GE and older GE low voltage power circuit breakers (Refer to DEH-4567). New, on-board features and communications capabilities enable equipment enhancements, improved operational performance and life extension programs. Performance will vary based on associated circuit breaker and equipment conditions.

This section describes the functions as implemented in the EntelliGuard G UL 489 and ANSI/UL 1066 circuit breakers. References or comparisons to other GE circuit breakers are for informational purposes only.

Reliability without Compromising Protection

Reliable protection of circuits and equipment has always been the circuit breaker's primary mission. Providing appropriate protection of the conductors, while preserving selective coordination, has been the primary focus of most system designers. However, what was acceptable in the past is no longer the standard today.

Modern economic reality, coupled with strict regulatory requirements, demand optimal system performance with increased sensitivity to the inherent power system hazards that face operating and maintenance personnel. Safety agencies, local authorities and owner-operators demand better personnel protection and state-of-the-art capabilities to minimize hazards while simultaneously preserving critical loads and system capabilities.

These requirements often seem to be, and sometimes are, in conflict, pitting the speed and sensitivity required to improve arc flash protection against the delays and deliberate decision making required to maximize power system reliability. The EntelliGuard TU, along with the EntelliGuard family of circuit breakers, offers flexible solutions for demanding circuit protection and circuit preservation environments. The EntelliGuard TU is designed to provide the utmost in system protection and reliability simultaneously, with little or no compromise.

Arc Flash and the EntelliGuard TU Trip Unit

Reducing arc flash hazard is a primary concern in many power system designs. The best way to ensure the lowest possible hazard for a particular distribution system is to consider the hazard as the system is designed and make careful selection of the system's topology, circuit sizes, equipment sizes and protective devices to minimize hazard for the operating and maintenance personnel that will need to use the system for years to come.

The EntelliGuard TU, especially in conjunction with the EntelliGuard G circuit breaker, provides significant flexibility towards solving arc flash hazard problems without excessive sacrifice of system reliability, in terms of selectivity.

One way to lower potential incident energy is to ensure that circuit breakers are able to interrupt using their Instantaneous trips for all expected arcing faults. Figure 3.1 shows the expected arcing currents for 480V systems for various arc gaps representative of switchgear (32mm), switchboards (25mm), MCCs (25mm) and panelboards (13mm). These values were determined using IEEE standard 1548, Guide for Performing Arc-Flash Hazard Calculations, 2002.

Figure 3.1. Arcing Current

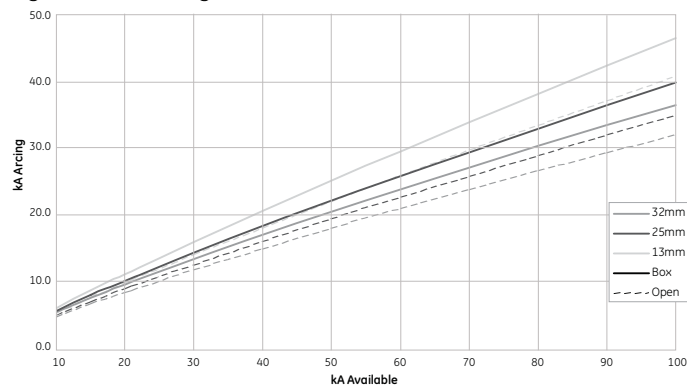


Figure 3.1 demonstrates the wide range of possible arcing currents predicted by the IEEE standard's calculations. The actual arcing currents may be lower or higher when consideration is given to the potential error in short circuit calculations, fault current data provided by the utility company, and variance in the actual arcing gap or enclosure's geometry where the arc occurs. Of particular concern should be the lower end of the possible range of current that may fall below the Instantaneous pickup of a circuit breaker or the current limiting threshold of a fuse. Dangerous incident energy may quickly increase when interruption time increases from a few cycles to a few seconds, even for low arcing current.

Selectivity with Molded Case Circuit Breakers and Other Devices

The EntelliGuard TU trip unit's adjustable selective instantaneous provides a unique selectivity capability. When used in conjunction with current limiting devices downstream, the trip unit may be set low, and still maintain significant levels of selectivity. Table 3.1 lists the minimum instantaneous setting above specific GE circuit breakers and the levels of selectivity achieved. Testing and documentation of the selectivity capability of the EntelliGuard Trip unit will be expanded as more test data becomes available. Always consult GE Selectivity reference publication DET-537 for the latest information or contact your GE sales representative for up to date information.

Selectivity above current limiting fuses may also be expected. The required minimum setting may be estimated by examining the peak let-through curve for the fuse. Find the peak let-through current value that is 1.41 times the prospective RMS current. The trip unit should be set such that the instantaneous pickup is above that peak value. The circuit breaker and fuse may then be selective up to the values identified in Table 3.1. The fuse and circuit breaker combinations have not been tested so performance cannot be guaranteed at this time; however, selectivity is expected for arcing and bolted faults up to the values indicated in the above selectivity table.

Protection between circuit breakers using the EntelliGuard TU trip unit may be further improved using zone selective interlocking. The trip unit's unique instantaneous zone selective interlocking which can increase selectivity for UL 489 EntelliGuard G mains while allowing to trip

instantaneously for faults within their zone of protection allows significant selectivity and arc flash protection at the same time.

Selectivity for an EntelliGuard TU ground fault function and a circuit breaker below may be enhanced by the trip unit's selective ground fault function and zone selective interlocking. Figure 3.2 demonstrates an 800A circuit breaker under a 1200A ground fault set to be fully selective. See also Tables 3.2 and 3.3.

Figure 3.2. Selectivity Curve

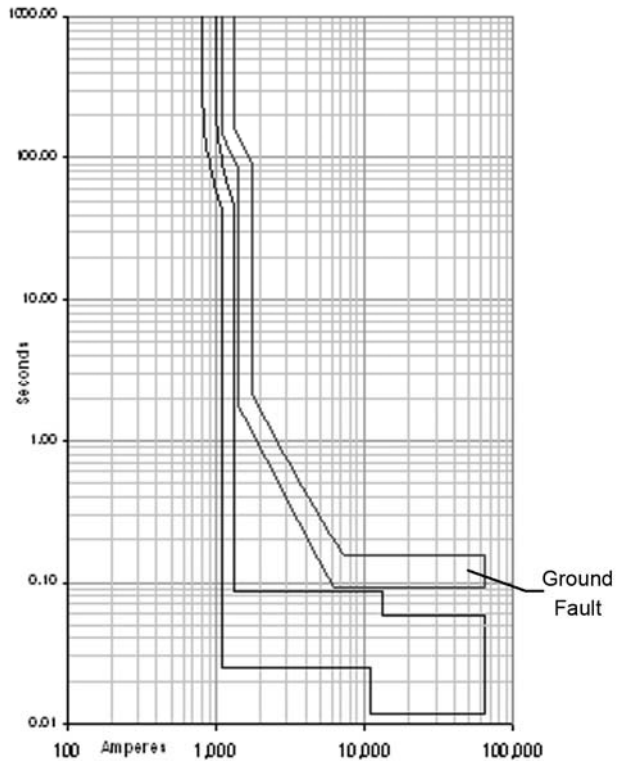


Table 3.1. EntelliGuard Selectivity Above GE Current Limiting Circuit Breakers

Load Side Device		Line Side Device with EntelliGuard TU Trip Unit				
Frame	Maximum Trip	Minimum Adjustable Selective Instantaneous Nominal Pickup in Amps at 208V to 480V	PowerBreak II, UL 489 CB	WavePro or AKR, ANSI CB	EntelliGuard G, UL 489 CB	EntelliGuard G, ANSI CB
Record Plus G	600A	20800A	Up to Short Circuit Rating; 65kA, 100kA and 150kA at 480V and 200kA at 240V	Up to Short Circuit Rating; 65kA and 100kA at 480V	Up to Withstand Rating; 42kA, 50kA, 65kA, or 85kA at 480V	Up to Withstand Rating; 65kA, 85kA, 100kA at 480V
Record Plus E	250A	10000A				
Record Plus B/C	100A	7200A				
Spectra G	600 A	30000A				
Spectra F	250A	18400A				
Spectra E	150A	18400A				

- Instantaneous selectivity between any other GE load side non-current-limiting circuit breaker and a line side circuit breaker with an EntelliGuard TU trip unit is verified via traditional time current curves. It may also be calculated by taking the maximum instantaneous setting of the upstream device, adjusted by its negative tolerance (-9.09%).
- Any instantaneous curve overlap seen between above CBs when the line side trip unit is set per the table does not indicate a lack of selectivity.

Table 3.2 Maximum Selectivity Above Non Current Limiting CB

Frame	Rating Plug	UL 489 EntelliGuard G CBs with Some Nominal Rating Plug Sizes			
		N	H	M	L
800	400	5,455	5,455	5,455	
	800	10,909	10,909	10,909	
1600	1200	16,364	16,364	16,364	
	1600	21,818	21,818	21,818	
2000	2000	27,273	27,273	27,273	
3000	3000	35,455	40,909	40,909	40,909
4000	4000			54,545	54,545
5000	5000			54,545	68,182
6000	6000			54,545	70,909

- Selectivity is calculated by multiplying the nominal instantaneous pickup setting in X times the rating plug and dividing by 1.1. The nominal instantaneous pickup setting in amperes cannot exceed 95% of the circuit breaker's claimed withstand rating.

Table 3.3. Maximum Selectivity Above Non Current Limiting CB

Frame	Max. Rating Plug	UL 1066 EntelliGuard G CBs with Some Nominal Rating Plug Sizes and Instantaneous Off					
		N	H	E	M	B	L
800	800	65,000	59,540	85,000	77,860		
1600	1600	65,000	59,540	85,000	77,860		
2000	2000	65,000	59,540	85,000	77,860		
3200	3200	65,000		85,000	77,860	100,000	91,600
4000	4000			85,000	77,860	100,000	91,600
5000	5000			85,000	77,860	100,000	91,600
Withstand Rating		65,000	65,000	85,000	85,000	100,000	100,000

- Selectivity with instantaneous on is calculated by multiplying the nominal Instantaneous pickup setting in X times the rating plug and dividing by 1.1. The nominal instantaneous pickup setting in amperes cannot exceed 95% of the circuit breaker's claimed withstand rating.

Above Downstream Feeders

The EntelliGuard TU trip unit has Short Time bands under 100msec designed to optimally fit above the Instantaneous clearing times of various GE circuit breakers. Table 3.4 lists the suggested Short Time band that may be used above specific GE circuit breakers for the fastest coordination and consequently fastest EntelliGuard G circuit breaker interruption.

Also listed is the Hazard Risk Category for various available fault currents calculated at the listed Short Time band clearing times and Instantaneous clearing times provided by the EntelliGuard TU trip unit's Adjustable Selective Instantaneous and its Reduced Energy Let-Through (RELT) Instantaneous trip. The Hazard Risk Category (HRC) levels shown are calculated for a solidly grounded, 480V system, 32mm arc gap, 18 in. working distance and arc in box. Using the optimized Short Time band allows the system to stay at HRC2 most of the time and always less than HRC4. However, use of the RELT Instantaneous trip allows the system to protect at HRC1 or 2 for available fault currents as high as 90kA.

The Adjustable Selective Instantaneous

The Instantaneous algorithm in the EntelliGuard TU trip unit will allow a large switchboard or switchgear circuit breaker to be set low yet maintain selectivity. For example, when set to protect the conductors to a motor control center, an 800A feeder circuit breaker's Instantaneous may be set as low as 8kA nominal. This should provide complete selectivity above the typical 150A and smaller circuit breakers or fuses found in a motor control center.

Allowing for 10% pickup tolerance in the Instantaneous pickup of the feeder circuit breaker would indicate that the feeder would pickup Instantaneously for arcing fault currents approximately 9kA or higher. From Figure 3.1 it can be seen that fault currents of 20-25kA and higher would seem to reliably produce arcing current above 9kA in a variety of configurations. From Table 3.4 it can be seen that an EntelliGuard G circuit breaker clearing instantaneously can maintain HRC1 in a system with up to 42kA available and HRC2 in systems with up to 100kA available – excellent arc flash protection and selectivity simultaneously!

Note: These incident energy calculations do not take into account motor contribution or other factors that may affect expected levels of incident energy or hazard. For a thorough understanding of the incident energy available or HRC in a power distribution system, an Arc Flash Study should be conducted by engineering personnel qualified to provide such analysis.

Table 3.4. Minimum Selective Clearing Times for an EntelliGuard G Circuit Breaker Above Selected GE Circuit Breakers, and Related HRC Levels at Various Fault Circuits

GE Molded Case Circuit Breaker Family	Circuit Breaker Type	Minimum EntelliGuard TU Short Time Band	Clearing Time	480V, 32mm, 24in Working Distance, Arc in a Box - HRC @ lbf=						
				35kA	42kA	50kA	60kA	75kA	90kA	100kA
FB, FC, TEY, THQL	TM, LP	0.025sec	0.08sec	2	2	2	2	3	3	3
TED, TEC	TM-GP, MCP	0.025sec	0.08sec	2	2	2	2	3	3	3
TF, TJ, TK	TM-GP	0.025sec	0.08sec	2	2	2	2	3	3	3
Spectra E, F, G Frame	E-GP	0.025sec	0.08sec	2	2	2	2	3	3	3
Spectra K Frame	E-GP	0.033sec	0.088sec	2	2	2	2	3	3	3
Spectra G, K with MVT trip	AE-GP	0.025sec	0.08sec	2	2	2	2	3	3	3
Record Plus G Frame	E, AE-GP	0.042sec	0.097sec	2	2	2	2	3	3	3
Record Plus E Frame	E-GP	0.033sec	0.088sec	2	2	2	2	3	3	3
Power Break with MVT	AE-GP	0.058sec	0.113sec	2	2	2	3	3	3	3
Instantaneous Clearing Time	-	instantaneous	0.050sec	1	1	1	2	2	2	2
RELT Clearing Time	-	RELT Instantaneous	0.042sec	1	1	1	1	2	2	2

TM = Thermal Magnetic. **AE** = Adjustable Electronic. **GP** = General Purpose Application. **HRC** = Hazard Risk Category (See NFPA 70E.
E = Electronic. **LP** = Lighting Panel Application. **MCP** = Motor Circuit Protector).

Above Other Power Circuit Breakers

Using the EntelliGuard TU trip unit's unique Instantaneous Zone Selective Interlocking (ZSI), the main circuit breaker also can be set to interrupt selectively for faults in its zone of protection. However, the pickup level must be nested to prevent a nuisance trip at the main. Allowing for a 10% tolerance in the pickup current of both trips, the upper boundary of the main's trip may be estimated at approximately 11kA. Again, Figure 3.1 shows that available fault currents above 25kA will generally produce arcing currents above 11kA. Table 3.4 shows a system with fault currents from 35kA to 100kA, the feeder and main circuit breaker will provide protection at HRC1 or HRC2 selectively above most circuit breakers using short time bands. Coordinated instantaneous settings would provide even better protection while still maintaining selectivity with select feeder breakers. To this capability one can add the RELT instantaneous setting that provides more sensitive and faster protection when needed.

Terminology

In: Trip plug rating in amperes. This is the current rating of the rating plug installed in the trip unit. This is the maximum Long Time pickup a trip unit can have with a specific plug installed. A sensor can usually be applied with plugs between 37.5% or 40% to 100% of the sensor rating. Plugs are labeled in amperes.

X: X is a multiplier that may be applied in front of any rating value to denote a fraction of that rating. Example: The Long Time Pickup may be set at 0.5X of In.

HSIOC: High Set Instantaneous Overcurrent, also known as the Override. This is an Instantaneous protection setting applied near the circuit breaker's withstand rating required to clear high magnitude faults quickly. In UL489 circuit breakers this is fixed; in UL1066 CBs the override may vary, if present at all.

MCR: Making Current Release. A setting provided with each trip unit, based on the specific circuit breaker size, used to protect the circuit against closing on high magnitude faults. The MCR function immediately trips/opens the circuit breaker if high magnitude fault current is sensed at the instant the circuit breaker is closed.

ICW: Short Circuit Withstand Rating of a particular circuit breaker in amperes. The withstand rating is defined differently within different standards, but it is always the value of current that a circuit breaker can withstand for some period of time without interrupting.

ICU: Short Circuit Interrupting Rating (ISC), or ultimate interrupting rating (ICU) in IEC terms. The maximum short-circuit interrupting rating of a circuit breaker in amperes.

Long Time Protection

The EntelliGuard TU offers two different shapes for Long Time protection curves. Each type of curve is available with 22 different time delays. The shapes may be described as thermal type I^2t characteristics and fuse shaped I^4t lines. The nominal Long Time pickup is computed from the trip rating plug value (I_n) multiplied by the Long Time pickup setting. Long Time pickup setting multipliers are user settings and may range from 0.5 to 1.0 in increments of 0.05. The actual Long Time pickup is 112% of the nominal setting (I_r). 112% is to compensate for the Long Time Pickup Tolerance of $\pm 10\%$ that is drawing as “actual value/1+ tolerance”. For a nominal 1000A Long Time pickup, the actual trip setting is 1120A, drawn as a vertical band between 1120/1.1 and 1120/0.9, or 1018A and 1244A.

Thermal Long Time Overcurrent

The thermal I^2t shape is similar to the typical curve of a thermal magnetic circuit breaker and matches the shape of many overcurrent devices used in industry today. The typical shape and range of settings may be seen in Figure 3.3. The range of time delays is shown in Table 3.5 at various multiples of nominal (100%) current setting. Drawn bands also include a mechanical constant time to account for circuit breaker operating and clearing time, which causes the slight widening of the band evident at the lower (right) end of the faster (lower) bands.

Figure 3.3. Thermal Characteristic: Maximum and Minimum Long Time Delay Bands for a 1000A Long Time Pickup

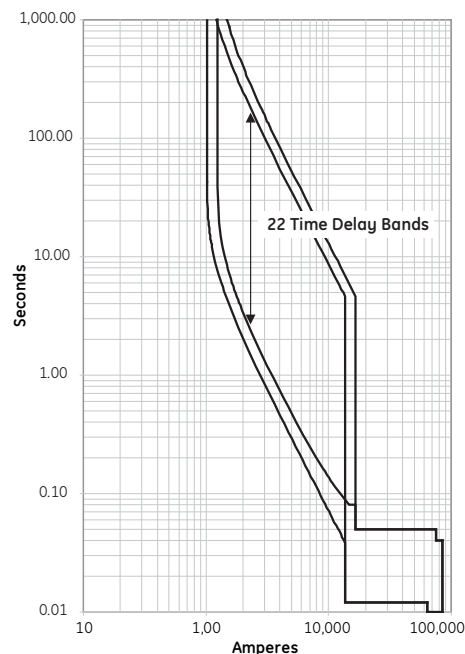


Table 3.5. Thermal Characteristic: Nominal Clearing and Commit Times for X Multipliers of Nominal Pickup

X=	1.5		7.2		10		12		15	
	Commit	Clear	Commit	Clear	Commit	Clear	Commit	Clear	Commit	Clear
Min CB	4.25	8.04	0.139	0.239	0.072	0.137	0.050	0.104	0.038	0.080
C-2	12.7	24.1	0.417	0.656	0.215	0.352	0.149	0.253	0.095	0.172
C-3	25.5	48.1	0.83	1.28	0.430	0.674	0.298	0.476	0.190	0.315
C-4	34.0	64.1	1.11	1.70	0.57	0.89	0.40	0.62	0.254	0.410
C-5	51.0	96.2	1.67	2.53	0.86	1.32	0.60	0.92	0.38	0.60
C-6	67.9	128	2.22	3.4	1.15	1.75	0.79	1.22	0.51	0.79
C-7	84.9	160	2.78	4.2	1.43	2.18	0.99	1.52	0.63	0.98
C-8	102	192	3.33	5.0	1.72	2.61	1.19	1.81	0.76	1.17
C-9	119	224	3.89	5.9	2.01	3.03	1.39	2.11	0.89	1.36
C-10	136	256	4.44	6.7	2.29	3.46	1.59	2.41	1.02	1.55
C-11	153	289	5.00	7.5	2.58	3.89	1.79	2.71	1.14	1.74
C-12	170	321	5.56	8.4	2.87	4.32	1.99	3.00	1.27	1.93
C-13	204	385	6.67	10.0	3.44	5.18	2.38	3.60	1.52	2.31
C-14	238	449	7.78	11.7	4.01	6.04	2.78	4.19	1.78	2.69
C-15	272	513	8.89	13.4	4.59	6.90	3.18	4.79	2.03	3.07
C-16	306	577	10.0	15.0	5.16	7.76	3.58	5.38	2.29	3.45
C-17	340	641	11.1	16.7	5.73	8.61	3.97	5.98	2.54	3.83
C-18	374	705	12.2	18.4	6.30	9.47	4.37	6.57	2.79	4.21
C-19	408	769	13.3	20.0	6.88	10.3	4.77	7.17	3.05	4.59
C-20	442	833	14.4	21.7	7.45	11.2	5.17	7.76	3.30	4.97
C-21	476	898	15.6	23.4	8.02	12.0	5.56	8.36	3.56	5.35
Max CB	510	962	16.7	25.1	8.60	12.9	5.96	8.95	3.81	5.73

- Algorithm will not commit below 1.5 cycles, clearing time will not be less than 0.08sec.
- Maximum LT curve is 15XLTPU for Envelope 1 and 2 devices, 10XLTPU for Envelope 3 devices.
- Actual Long Time pickup is 112% of nominal pickup.

Fuse-Shaped Steep Long Time Overcurrent

The optional steeper fuse characteristic is a straight line $K=t^4$ shape for application in systems where fuses and circuit breakers are used together. Twenty-two different time bands are available in each trip unit.

Figure 3.4 displays minimum and maximum bands. Table 3.6 displays the nominal time delays for each of the 22 bands at various multiples of nominal current pickup.

Drawn bands also include a 30 ms constant time, which accounts for the slight widening evident in the time current curve at the lower (right) end of the faster (lower) time bands.

Figure 3.4. Fuse Characteristic: Maximum and Minimum Long Time Delay Bands for a 1000A Long Time Pickup

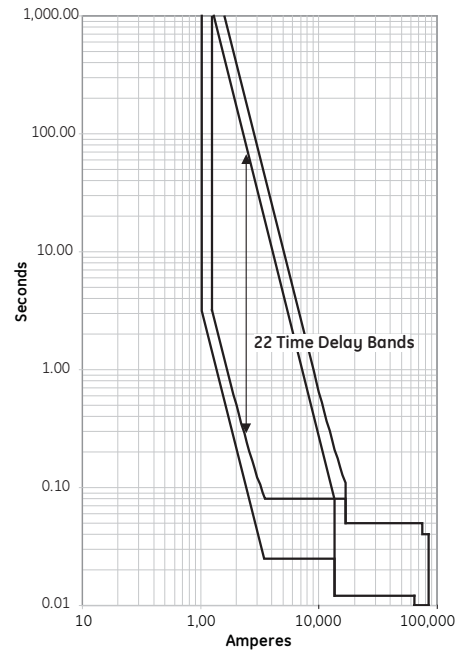


Table 3.6. Fuse Characteristic: Nominal Clearing and Commit Times for X Multipliers of Nominal Pickup

X=	1.5		7.2		10		12		15	
	Commit	Clear	Commit	Clear	Commit	Clear	Commit	Clear	Commit	Clear
Min Fuse	0.675	1.51	0.025	0.080	0.025	0.080	0.025	0.080	0.025	0.080
F-2	1.96	4.37	0.025	0.080	0.025	0.080	0.025	0.080	0.025	0.080
F-3	3.56	7.95	0.025	0.080	0.025	0.080	0.025	0.080	0.025	0.080
F-4	5.57	12.4	0.025	0.080	0.025	0.080	0.025	0.080	0.025	0.080
F-5	8.07	18.0	0.025	0.080	0.025	0.080	0.025	0.080	0.025	0.080
F-6	11.2	25.0	0.025	0.080	0.025	0.080	0.025	0.080	0.025	0.080
F-7	15.1	33.7	0.028	0.080	0.025	0.080	0.025	0.080	0.025	0.080
F-8	20.0	44.7	0.038	0.084	0.025	0.080	0.025	0.080	0.025	0.080
F-9	26.1	58.3	0.049	0.110	0.025	0.080	0.025	0.080	0.025	0.080
F-10	33.8	75.4	0.064	0.142	0.025	0.080	0.025	0.080	0.025	0.080
F-11	43.3	96.7	0.082	0.182	0.025	0.080	0.025	0.080	0.025	0.080
F-12	55.3	123	0.104	0.232	0.028	0.080	0.025	0.080	0.025	0.080
F-13	70.2	157	0.132	0.295	0.036	0.080	0.025	0.080	0.025	0.080
F-14	88.9	198	0.167	0.374	0.045	0.100	0.025	0.080	0.025	0.080
F-15	112	251	0.211	0.472	0.057	0.127	0.027	0.080	0.025	0.080
F-16	141	316	0.266	0.595	0.072	0.160	0.035	0.080	0.025	0.080
F-17	178	397	0.335	0.748	0.090	0.201	0.043	0.097	0.025	0.080
F-18	224	499	0.421	0.940	0.113	0.252	0.055	0.122	0.025	0.080
F-19	280	626	0.528	1.179	0.142	0.317	0.068	0.153	0.028	0.080
F-20	352	785	0.663	1.479	0.178	0.397	0.086	0.192	0.035	0.080
F-21	441	984	0.830	1.853	0.223	0.498	0.108	0.240	0.044	0.098
Max Fuse	540	1204	1.017	2.269	0.273	0.610	0.132	0.294	0.054	0.120

- Algorithm will not commit below 1.5 cycles, clearing time will not be less than 0.08sec.
- Maximum LT curve is 15XLTPU for Envelope 1 and 2 devices, 10XLTPU for Envelope 3 devices.
- Actual Long Time pickup is 112% of nominal pickup.

Thermal Memory

The Long Time and Short Time pickup algorithm also includes a cooling cycle that keeps track of current if it oscillates in and out of pickup range. This Thermal Memory is also active in case the circuit breaker trips on Long Time or Short Time to account for residual heating in conductors. If a circuit breaker is closed soon after a Long Time trip or Short Time trip, a subsequent trip may happen faster than indicated by the time current curve due to the residual cable Thermal Memory effect. In trips without control power, the Thermal Memory is powered from the Trip Unit battery. The cooling algorithm requires up to 14 minutes to fully reset to zero.

Short Time Protection

Short Time Pickup

The EntelliGuard TU provides a wide range of Short Time pickup settings, I²t characteristics and time bands to optimize selectivity while not sacrificing clearing time unnecessarily. Short Time pickup settings range from 1.5 to 12 times the Long Time pickup setting for the EntelliGuard G circuit breakers in Envelopes 1 and 2. The maximum Short Time pickup for Envelope 3 is 10. In Power Break, WavePro, AKR and other circuit breakers, the maximum Short Time pickup may be lower. The transition between Long Time band and Short Time function may happen at the horizontal Short Time Delay Band rather than the vertical Short Time pickup, depending on the following:

- How fast or what type of Long Time band is chosen
- What Short Time pickup is selected
- What Short Time Delay is selected

An example of this may be seen in Figure 3.5 for the combination of Long Time Delay Band and Short Time Delay Band shown in Figure 3.6, any Short Time pickup setting larger than 6X will result in the Long Time band intersecting with the horizontal Short Time delay band rather than the vertical Short Time pickup.

Short Time Bands

The EntelliGuard TU comes with a wide range of adjustable Time Delay Bands, ranging from a minimum of 25ms (clears in 80ms) to 417ms (clears in 472ms). The bands are specially designed to pickup above various circuit breakers and trip systems to provide required selectivity while not sacrificing any more clearing time than required to provide the best possible arc flash protection.

The time bands are shown in Table 3.7 and Figure 3.7.

Figure 3.5. Short Time Pickup

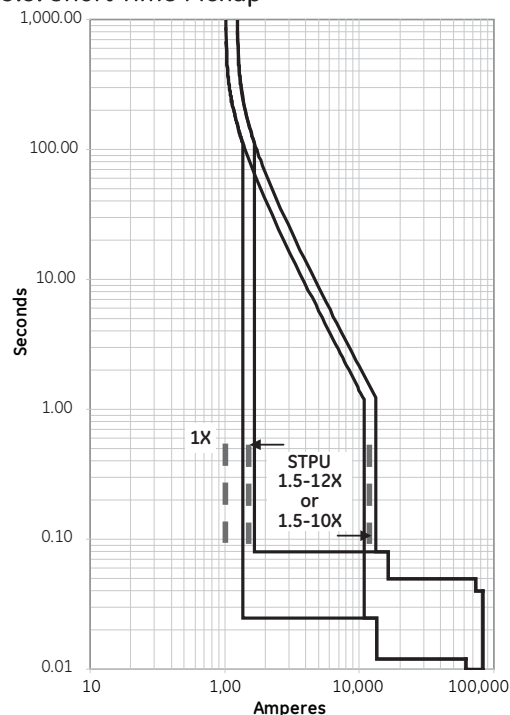


Figure 3.6. Short Time Transition

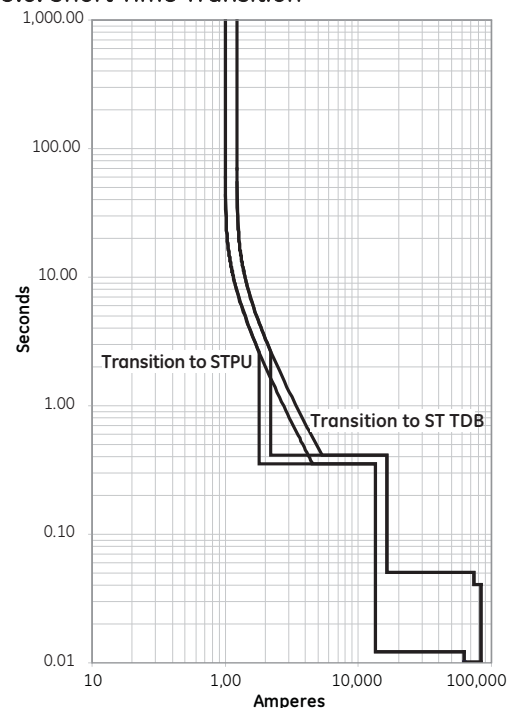
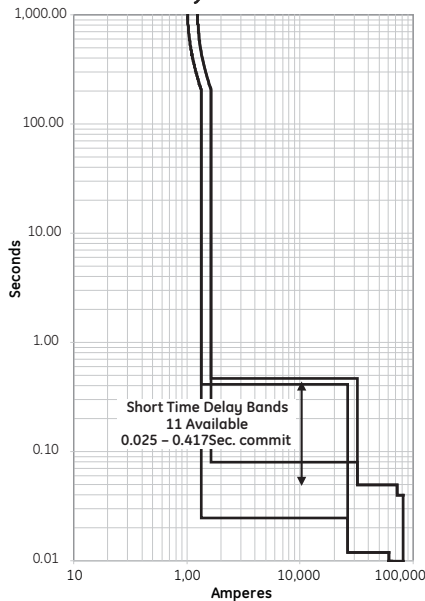


Table 3.7. Short Time Delay Bands

Label	Pickup	Clearing
Minimum	0.025	0.080
2nd	0.033	0.088
3rd	0.042	0.097
4th	0.058	0.113
5th	0.092	0.147
6th	0.117	0.172
7th	0.158	0.213
8th	0.183	0.238
9th	0.217	0.272
10th	0.350	0.405
Maximum	0.417	0.472

Figure 3.7. Short Time Delay



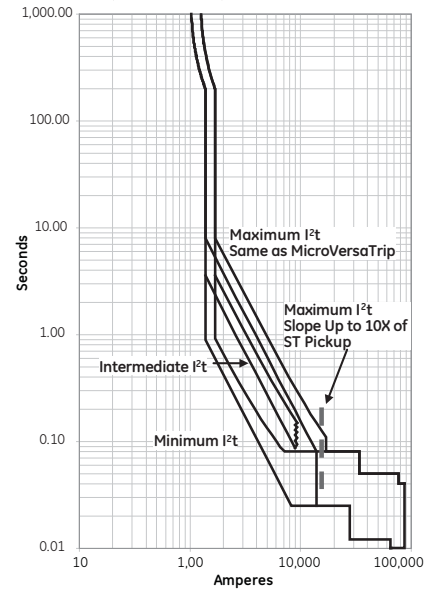
Short Time I^2t Slopes

The EntelliGuard Trip Unit offers three different Short Time I^2t characteristics to allow optimized settings for selectivity and fast protection whenever possible. When using the EntelliGuard Trip Unit in systems that also employ older GE MVT trip units, the EntelliGuard Trip Unit's maximum I^2t characteristic is equal to the Short Time I^2t characteristic in the MVT trip.

The position of the I^2t slopes varies with the Long Time pickup of the respective circuit breaker. The intersection of the Short Time pickup and the Short Time delay band with the I^2t slope varies with the Short Time pickup and time delay band.

The three positions for the Short Time I^2t band are shown in Figure 3.8. The bands may be defined by the formula $K = I^2t$, where K equals 18, 8 and 2 times the nominal Long Time pickup squared. A 30msec fixed time is added to account for circuit breaker mechanical operation, clearing time and variance. Pickup tolerance is 10% of current.

Figure 3.8. Short I^2t (In or Out)



The maximum (upper) Short Time I^2t band may not be used with the minimum Long Time thermal band. Use of the fuse shaped Long Time bands also inhibits use of the Short Time I^2t bands. Only the definite time Short Time pickup characteristic may be used with the fuse shaped Long Time curves.

Ground Fault Protection

The EntelliGuard TU trip unit offers the ultimate in Ground Fault protection. Each trip unit may be provided with the ability to accept a neutral sensor signal and generate an internal Zero Sequence phasor for Ground Fault protection. It may also be equipped with the ability to accept a Zero Sequence phasor signal from an external Zero Sequence CT or residual summation scheme using current transformers. Either Ground Fault method may be used to provide Ground Fault trip or Ground Fault alarm. Four pole circuit breakers may also provide Ground Fault protection based on an external Zero Sequence input signal or a residual sum of all four internal sensors.

Internal Residual Summation

The EntelliGuard TU trip unit uses internal air core sensors for current sensing, and the signals are residually summed using advanced digital electronics. A neutral sensor may be located remotely and connected to the trip unit. The connection is limited to 10m (33ft). Due to the air core sensor's ability to handle a wide range of primary currents without distortion, Ground Fault sensing is accurate for a wide range of phase and current inputs.

External Zero Sequence Input

The EntelliGuard TU trip unit is able to accept input from an externally calculated Ground Fault current. The Ground Fault current may be derived using a single Zero Sequence CT or multiple phase CTs connected in a residual summation scheme. External CE marked Zero Sequence or ground return CTs are available for IEC applications, but are not UL Listed. Phase CTs used for a summation connection are UL Listed. Applications for this capability include sensing at the ground return connection for a transformer or generator as well as application in multiple source grounded systems.

Ground Fault Pickup Settings

All UL 489 and UL 1066 circuit breakers are limited to a maximum nominal pickup setting of 1200A per the National Electrical Code or 60% of the sensor size, whichever is lower. The minimum setting is 20% of sensor size. The available maximum settings per sensor may be seen in Table 3.8.

Table 3.8. Ground Fault Time Delay Bands

Sensor	Minimum	Maximum
400	0.2	0.60
600	0.2	0.60
800	0.2	0.60
1200	0.2	0.60
1600	0.2	0.60
2000	0.2	0.60
2500	0.2	0.48
3000	0.2	0.40
3200	0.2	0.37
4000	0.2	0.30
5000	0.2	0.24
6000	0.2	0.20

Ground Fault Time Delay Bands

Ground Fault Time Delay Bands used in the EntelliGuard G circuit breakers range from 42msec to 942msec. In Power Break I, Power Break II, WavePro and AKR circuit breakers, the minimum GF Time Delay Band is 58msec and the maximum is 417msec.

The available minimum settings per circuit breaker type are shown in Table 3.9. The maximum Time Delay Band setting for all circuit breakers is 0.940sec with a 1sec clear.

Table 3.9. Minimum Ground Fault Pickup and Clear Time

Setting	Power Break I & II, AKR & WavePro	EntelliGuard G
Minimum pickup	0.058sec	0.042sec
Minimum clear	0.113sec	0.097sec
Maximum pick	0.417sec	0.940sec
Maximum clear	0.470sec	1.000sec

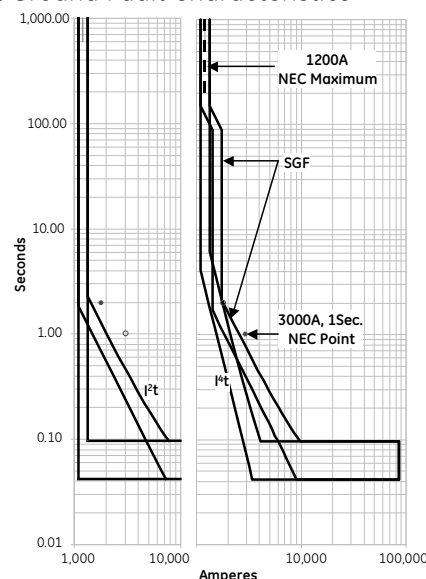
Ground Fault Protection Curves

The EntelliGuard TU trip unit offers four different shapes for the ground fault function:

- Definite time with adjustable time delay.
- I^2t slope with adjustable time delay.
- I^4t slope (fuse shaped) with adjustable time delay.
- Selective double break I^2t with adjustable time delay.

The definite time and I^2t characteristics provide the traditional GF curve shapes. The I^4t characteristic provides a shape more in line with downstream fuses. GE's unique selective double break I^2t characteristic provides the most selective setting possible while still meeting the applicable UL and NEC standards. In many cases, an 800A circuit breaker may be used under a 1200A ground fault curve selectively (Fig. 3.9).

Figure 3.9. Ground Fault Characteristics



Instantaneous Protection

The EntelliGuard TU trip unit may provide several types of Instantaneous protection, depending on the circuit breaker in which it is installed. The different types of Instantaneous protection are as follows:

- *Adjustable Selective Instantaneous:* Provided on Power Break II, WavePro, AKR and EntelliGuard G.
- *Extended Range Adjustable Selective Instantaneous:* An available option on ANSI EntelliGuard G circuit breakers.
- *High Set Instantaneous Overcurrent Trip:* Provided on Power Break II and some EntelliGuard G circuit breakers, also called an override.
- *Making Current Release (MCR):* Provided on all EntelliGuard G circuit breakers.
- *Reduced Energy Let-Through Instantaneous Trip:* An available option on Power Break II, WavePro, AKR and EntelliGuard G circuit breakers.

Each of these Instantaneous trips provides optimum protection, selectivity or both as required for different applications, subject to the capabilities of the respective circuit breakers in which the trip units are installed.

Adjustable Selective Instantaneous

The EntelliGuard TU uses an exclusive algorithm, developed by GE, to recognize the wave shape of fault current within a cycle. With the improved analysis of the fault current wave shape, the trip unit allows the circuit breaker to trip immediately yet provide superior selectivity when used above current limiting circuit breakers or fuses. In many cases, the trip unit's Instantaneous pickup may be set quite low yet allow for complete selectivity up to the circuit breaker's full withstand level. For a list of possible selective combinations of GE circuit breakers employing the EntelliGuard TU trip unit and various downstream overcurrent devices, see GE publication DET-536.

The EntelliGuard TU trip unit can be furnished with one of two Instantaneous adjustment ranges. The standard adjustable range may be as high as 15X the trip plug value on all UL 489 or UL 1066 circuit breakers. An optional Extended Range Adjustable Selective Instantaneous, as high as 30X, may be provided for UL 1066 Listed Low Voltage Power Circuit Breakers (LVPCBs). LVPCBs also allow for this adjustable Instantaneous trip to be turned off. The minimum adjustable Instantaneous pickup setting for all circuit breakers is 2X the trip plug rating. The available maximum pickup settings are described in Table 3.10. The maximum Instantaneous pickup is limited by the circuit breaker's withstand rating.

Table 3.10. Maximum Adjustable Instantaneous Pick-up for EntelliGuard G Circuit Breakers with Normal or Extended Range Option

“In” (Plug Rating, A)	Withstand Rating									
	42		50		65		85		100	
	Normal Range	Extended Range	Normal Range	Extended Range	Normal Range	Extended Range	Normal Range	Extended Range	Normal Range	Extended Range
150-2,000	15	N/A	15	N/A	15	30	15	30	15	30
2,200	N/A	N/A	15	N/A	15	28	15	30	15	30
2,400	N/A	N/A	15	N/A	15	25	15	30	15	30
2,500	N/A	N/A	15	N/A	15	24	15	30	15	30
3,000	N/A	N/A	15	N/A	15	20	15	26	15	30
3,200	N/A	N/A	N/A	N/A	15	19	15	25	15	29
3,600	N/A	N/A	N/A	N/A	15	17	15	22	15	26
4,000	N/A	N/A	N/A	N/A	15	15	15	20	15	23
5,000	N/A	N/A	N/A	N/A	N/A	N/A	15	16	15	19
6,000	N/A	N/A	N/A	N/A	N/A	N/A	13	N/A	N/A	N/A

The Adjustable Selective Instantaneous will clear a fault in three cycles when used in 60Hz or 50Hz applications. Zone Selective Interlocking (ZSI) may be used with this Instantaneous function, allowing several breakers with overlapping Instantaneous protection to be selective with each other. Because each circuit breaker is set to trip Instantaneously for faults within their respective zones of protection, fast protection and selectivity are achieved simultaneously.

The special selective Instantaneous algorithm allows any circuit breaker above current limiting devices to be set with a relatively low Instantaneous pickup and still achieve significant selectivity. The system may be able to provide Instantaneous protection for most faults, including high impedance arcing fault, while maintaining significant levels of selectivity. Figures 3.11 and 3.12 later in this document demonstrate the performance of the Instantaneous ZSI capability.

High Set Instantaneous Overcurrent (HSIOC)

The EntelliGuard TU trip unit's HSIOC pickup is similar to the fixed override used by other trip units and circuit breakers in the industry. In EntelliGuard G, the HSIOC setting is changed automatically by the trip unit if the normal adjustable Instantaneous is turned off (LVPCB only). When adjustable Instantaneous setting is turned off, HSIOC nominal setting becomes 98% of the circuit breaker's Short Time withstand setting. In all other cases, in the EntelliGuard G family of circuit breakers, the HSIOC is set high enough to allow full selectivity up to the circuit breaker's short time withstand rating.

For circuit breakers with a HSIOC trip function, the location of the HSIOC trip is shown by the line that reaches the 0.01sec axis at the bottom of the TCC. The location of that line is shown in Table 3.11. In many applications, the EntelliGuard G circuit breaker with an EntelliGuard TU trip unit will be completely selective up to the HSIOC pickup or the circuit breaker's full short circuit rating, even with the adjustable Instantaneous on.

Table 3.11. HSIOC Locations

Short Circuit Tier	Interrupting Rating (A)					UL489 Override	UL1066 Override
	240V	480V	600V	UL489 I_{cw}	UL1066 I_{cw}		
N	65,000	65,000	65,000	42,000	65,000	42,000	None
H	85,000	85,000	65,000	50,000	65,000	50,000	65,000
E	85,000	85,000	85,000	N/A	85,000	N/A	None
M	100,000	100,000	85,000	65,000	85,000	65,000	85,000
B	100,000	100,000	100,000	N/A	100,000	N/A	None
L	150,000	150,000	100,000	85,000	100,000	85,000	10,000

• All UL Overrides are -0% tolerance, ANSI Override pickup at -0% or -9% based on Adjustable Selective Instantaneous being on or off.

Reduced Energy Let-Through (RELT) Instantaneous Trip

The EntelliGuard TU trip unit provides an optional second, user-adjustable, RELT Instantaneous trip. This trip provides an alternate Instantaneous setting that allows a user to temporarily set a circuit breaker to a more sensitive pickup to provide better protection, only when better protection is needed and some selectivity may be sacrificed. The RELT pickup is adjustable from 1.5X to 15X of plug rating, independently of the normal adjustable selective Instantaneous. It may be set higher or lower than the selective Instantaneous.

The user must make two entries at the trip unit: (1) Pickup settings (1.5-15X of the plug) and (2) ON, OFF or REMOTE. ON/OFF enables or disables the pickup setting. REMOTE allows the RELT Instantaneous pickup to be enabled via application of 24Vdc or Vac at the RELT input terminals or serial communications via the Modbus or Profibus communication port. The RELT pickup may be enabled via serial communication or remote 24V signal, but both need to be indicating "OFF" for the RELT Instantaneous pickup to be disabled. The RELT input command may be wired to a manual switch, automatic sensor or, via external logic, to one or more signal sources.

Making Current Release (MCR)

This form of Instantaneous protection is provided on all EntelliGuard G circuit breakers. This function provides protection in case the circuit breaker is closed on an unusually high current. A circuit breaker that experiences 15 times (15x) or more its plug rating is possibly closing in on a fault caused by incorrectly wired conductors, forgotten grounding cables or some other type of unusual low impedance fault.

Alternatively, it is closing on a very low impedance arcing fault. In either case, there is a possibility that equipment may be damaged by the high fault current or an arc flash hazard has been inadvertently created. The MCR provides very fast protection when the circuit breaker is closed and for the first six cycles thereafter. After the six cycles have elapsed, the MCR is turned off and the circuit breaker reverts to its adjustable Instantaneous pickup and HSIOC if provided. The MCR will clear fault current in 40msec or less.

When the EntelliGuard TU trip unit has the RELT Instantaneous pickup enabled, the trip unit provides a feedback signal via an optically isolated dry contact and serial communication. This provides positive feedback that the trip unit has received and reacted to the RELT Enable command.

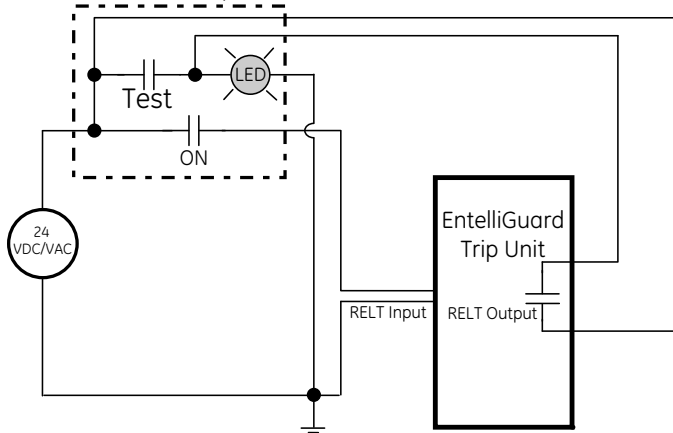
The EntelliGuard TU trip unit's RELT capability provides the ultimate in user flexibility for wiring and controlling an alternate Instantaneous setting for temporary use to reduce personnel hazard. The RELT Instantaneous pickup clears fault current in 42msec or less at 60Hz.

RELT capability may be provided on a trip unit with or without control power. If 24V is provided to the RELT input, the trip unit will use the RELT Instantaneous trip setting. However, without control power connected to the trip unit permanently, indication that the trip unit is in the RELT mode may not be reliably communicated. If reliable communication that the trip unit is in the RELT mode is desired, it is suggested that the trip unit be permanently connected to 24Vdc control power.

Reduced Energy Let-Through Switch Wiring

The RELT switch may be connected to a manually operated two-position switch, a remote sensor, or both simultaneously. The EntelliGuard TU trip unit provides a feedback capability directly from the trip so the user is able to verify that the signal was received by the trip unit and the settings have changed. Optionally, an indicating light may also be connected to the source of control power so the user knows if control power is available to change the setting. The trip unit does not require its own control power to accept a RELT input and change the Instantaneous trip pickup according to the user settings. However, if control power is available to the trip unit, the feedback signal will function immediately, rather than when the trip unit becomes self-powered through its load current (Fig. 3.10).

Figure 3.10. Integrated Switch and LED, Spring Return from "Test" to "Off," Latched in "On"



- This configuration provides positive indication that the trip unit has received and processed the RELT "On" signal. It also provides a control power check. Caution: It is recommended that RELT output be wired to an appropriate annunciation when remote activation control of RELT is used.

NOTE: When using the RELT function in conjunction with remote enable/disable control, it is strongly recommended that the trip unit be provided with permanently connected control power and that the RELT status output be assigned to a trip output contact. The trip output contact should be wired to appropriately located annunciation. The trip unit will accept a command to enable the RELT instantaneous pickup setting via local HMI control, a 24Vac/dc voltage applied at the input terminals or serial communication. Regardless how the enable command is received, the trip unit will be in the RELT mode when protection is required. However, the status indicating contacts will only close if the trip unit is powered through the internal current transformers or 24Vdc control power. Lack of 24Vdc control power could provide unreliable indication of RELT status due to low load conditions on the circuit breaker.

Zone Selective Interlocking (ZSI)

The EntelliGuard TU trip unit's ZSI capability differs from that found in other circuit breaker trips in two significant ways:

1. It allows independent and separate settings of the unrestrained (in zone protection) and the restrained (back up protection) bands.
2. It provides simultaneous and independent ZSI of both the Short Time and Instantaneous protection. This allows each circuit breaker to zone interlock with upper tier circuit breakers between ST band to ST band, Instantaneous to Instantaneous, or Instantaneous to Short Time.

The EntelliGuard TU trip unit's fast ZSI system is able to interlock Ground Fault, Short Time and Instantaneous. When required for feeder selectivity the main is able to be set faster than the feeder without any sacrifice in selectivity. As long as the main breaker's pickup is set above the feeder's pickup the two devices will remain selective. Each circuit breaker in a ZSI scheme allows separate user settings for the restrained (backup) and unrestrained (in zone protections) for ground fault and short time protection. For the lowest tier device in the scheme the restrained and unrestrained are set to the same values. For instantaneous protection there is only one pickup setting required.

Instantaneous protection may also be interlocked such that all circuit breakers above the one whose zone has the fault will shift from Instantaneous clearing to a 0.058msec time band. Since it is expected that faults of sufficient magnitude to engage the Instantaneous pickup are dangerously high, all zone selective interlocked Instantaneous trips that receive a restraint signal are shifted to the same band. Should the bottom circuit breaker fail to clear for whatever reason, quick back up protection from both ties and feeders is provided.

Short Time and Ground Fault bands for zone interlocked circuit breakers may be set to any band available to the trip. Figure 3.11 shows two circuit breakers set to protect at their unrestrained settings. Figure 3.12 shows the same two circuit breakers while a fault is detected below the lower circuit breaker in the system and after a restraint signal is received by the upper circuit breaker's trip unit. The upper circuit breaker's Short Time band has shifted from the user setting of 0.025sec to a user set restrained band of 0.092sec. The Instantaneous has shifted from the adjustable selective Instantaneous band clearing in 0.050sec to the fixed restrained band of 0.058sec, clearing in 0.113sec. This allows the lower circuit breaker to clear faults within their zone of protection above 7,000A RMS and 11,000A RMS respectively, clearing under 100msec, while maintaining full selectivity for faults up to 85,000A.

Figure 3.11. Zone Selective Interlocked CB, Upper CB Shown “Unrestrained”

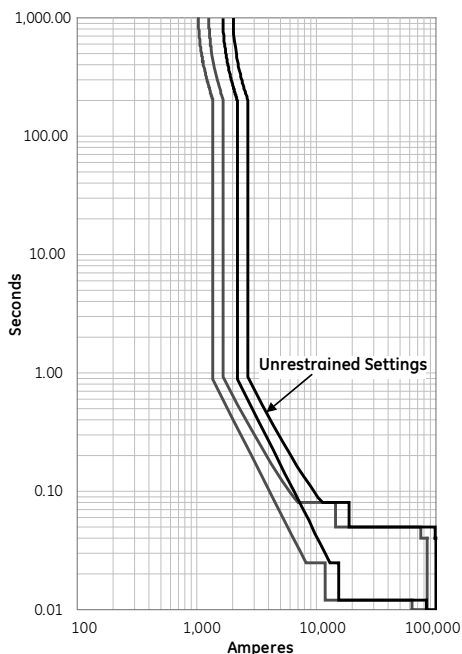
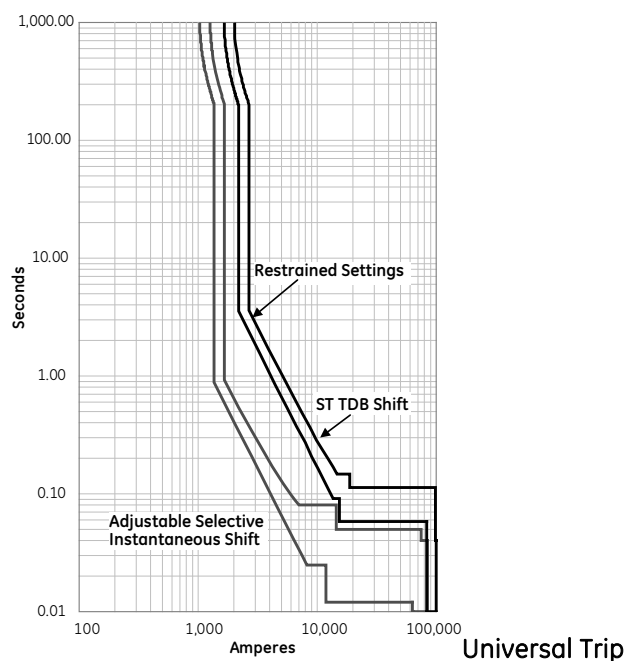


Figure 3.12. Zone Selective Interlocked CB, Upper CB Shown “Restrained”



Rating Plugs

The EntelliGuard TU trip system is composed of trip units and trip rating plugs along with the sensors and wiring provided in the EntelliGuard G circuit breaker to support the trip. Rating plugs are used to lower the Long Time adjustment range of the sensor provided in the circuit breaker.

The EntelliGuard TU trip rating plugs are unique in that they can be used with multiple trip units and circuit breakers within a specific sensor range, rather than only with a single specific sensor. The trip rating plug catalog number, shown in Figure 3.13, identifies the rating as well as the minimum and maximum sensor rating the plug may be used with. Table 3.12 lists trip rating plugs available for each sensor. Table 3.13 lists the two-digit codes used within the trip rating plug catalog numbers and the sensor current ratings to which they are mapped.

Figure 3.13. EntelliGuard Trip Unit Rating Plug Catalog Number Guide

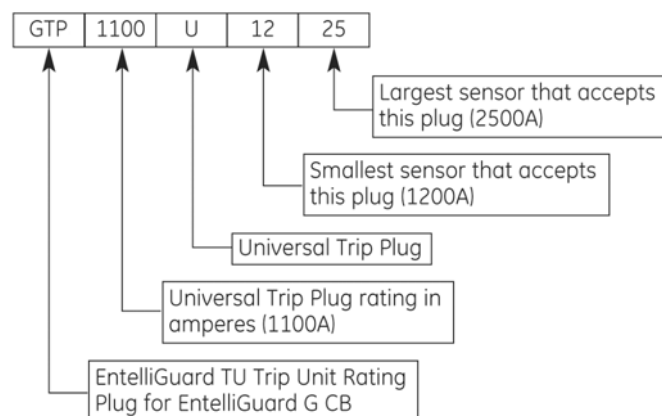


Table 3.12. Trip Rating Plug Specifications

Trip Plug Catalog Number	Plug Rating	May Be Used With	
		Minimum Sensor	Maximum Sensor
GTP0060U0101	60A ¹	150A ³	150A ³
GTP0080U0102	80A ¹	150A ³	200A ⁴
GTP0100U0102	100A ²	150A ³	200A ⁴
GTP0125U0102	125A ¹	150A ³	200A ⁴
GTP0150U0404	150A	150A ³	400A
GTP0200U0404	200A	200A ⁴	400A
GTP0225U0406	225A	400A	600A
GTP0250U0407	250A	400A	630A ⁵
GTP0300U0408	300A	400A	800A
GTP0350U0408	350A	400A	800A
GTP0400U0410	400A	400A	1000A
GTP0450U0612	450A	600A	1200A
GTP0500U0613	500A	600A	1250A ⁵
GTP0600U0616	600A	600A	1600A
GTP0700U0816	700A	800A	1600A
GTP0750U0820	750A	800A	2000A
GTP0800U0820	800A	800A	2000A
GTP0900U1020	900A	1000A	2000A
GTP1000U1025	1000A	1000A	2500A
GTP1100U1225	1100A	1200A	2500A
GTP1200U1232	1200A	1200A	3200A
GTP1500U1640	1500A	1600A	4000A
GTP1600U1640	1600A	1600A	4000A
GTP1900U2050	1900A	2000A	5000A
GTP2000U2050	2000A	2000A	5000A
GTP2200U2550	2200A	2500A	5000A
GTP2400U2564	2400A	2500A	6400A ⁵
GTP2500U2564	2500A	2500A	6400A ⁵
GTP3000U3064	3000A	3000A	6400A ⁵
GTP3200U3264	3200A	3200A	6400A ⁵
GTP3600U4064	3600A	4000A	6400A ⁵
GTP4000U4064	4000A	4000A	6400A ⁵
GTP5000U5064	5000A	5000A	6400A ⁵
GTP6000U6064	6000A	6000A	6400A ⁵

- 1 WavePro & AKR only. EntelliGuard G min. trip plug is 150A.
- 2 PowerBreak only. EntelliGuard G min. trip plug is 150A.
- 3 WavePro & AKR only. EntelliGuard G min. sensor is 400A.
- 4 PowerBreak only. EntelliGuard G min. sensor is 400A.
- 5 IEC only sensor, UL equivalents are 600A.

Table 3.13. Trip Rating Plug Codes

Sensor Designation	Sensor Rating
01	150A ¹
02	200A ²
04	400A
06	600A
07	630A ³
08	800A
10	1000A
12	1200A
13	1250A ³
16	1600A
20	2000A
25	2500A
30	3000A
32	3200A
40	4000A
50	5000A
60	6000A
64	6400A ³

- 1 Sensor available in WavePro and AKR only.
- 2 Sensor available in Power Break only.
- 3 Sensor available in IEC listed circuit breaker only.

Table 3.14 lists the plugs available for each sensor in the various circuit breakers in which the EntelliGuard TU may be installed.

Table 3.14. EntelliGuard G Rating Plug Logic (UL 489, UL 1066, IEC)

Breaker Frame/Sensor (A)															
All	UL/ANSI	IEC	All	All	UL/ANSI	IEC	All	All	All	UL	IEC/ANSI	All	All	UL/IEC	IEC
400	600	630	800	1000	1200	1250	1600	2000	2500	3000	3200	4000	5000	6000	6400
150															
200															
225	225														
250	250	250													
300	300	300	300												
350	350	350	350												
400	400	400	400	400											
	450	450	450	450	450										
	500	500	500	500	500	500									
	600	600	600	600	600	600	600								
		630	630	630	630	630	630								
			700	700	700	700	700								
			750	750	750	750	750	750							
			800	800	800	800	800	800							
				900	900	900	900	900							
				1000	1000	1000	1000	1000	1000						
					1100	1100	1100	1100	1100						
					1200	1200	1200	1200	1200	1200	1200				
						1250	1250	1250	1250	1250	1250				
							1500	1500	1500	1500	1500	1500			
							1600	1600	1600	1600	1600	1600			
								1900	1900	1900	1900	1900	1900		
								2000	2000	2000	2000	2000	2000		
									2200	2200	2200	2200	2200		
									2400	2400	2400	2400	2400	2400	2400
									2500	2500	2500	2500	2500	2500	2500
										3000	3000	3000	3000	3000	3000
											3200	3200	3200	3200	3200
												3600	3600	3600	3600
												4000	4000	4000	4000
													5000	5000	5000
														6000	6000
															6400

Universal Spare Trip Unit

EntelliGuard G circuit breakers will accept a Universal Spare Trip Unit. This unique trip unit may be used in any EntelliGuard G circuit breaker regardless of frame size, sensor size, short circuit rating or whether the circuit breaker is listed under UL 489, ANSI/UL 1066 or IEC 947 standards. Should any circuit breaker's trip unit fail to operate for any reason, this one universal trip unit may be used as a replacement.

Once an EntelliGuard TU trip unit, including the Universal Spare Trip Unit, is associated with a specific EntelliGuard G circuit breaker, it may only be used with that specific circuit breaker. If swapping between EntelliGuard G circuit breakers is required, a trip unit may only be swapped between circuit breakers with equal sensor ratings, short circuit ratings and standard listing. Before the circuit breaker may be used with a swapped or new trip unit, the trip unit must be mapped to the circuit breaker.

The mapping procedure is described in the trip unit instruction book and requires that control power be provided to the trip unit from permanently connected control power or a portable power supply that may be connected via the trip unit's front test and communication connection.

Universal Trip Units may be ordered with a limited set of options. It is suggested that they be ordered with the widest range of options used within a facility, as any unnecessary functions can always be disabled or turned off (except for Ground Fault) during set up by the user. The user-selected options for the Universal Trip Unit are listed in Table 3.15.

Table 3.15. Universal Spare Trip Unit Options (User-Selected)

Feature	#	Option
Long Time	1	Standard
	2	Standard and Fuse
Instantaneous	1	Standard
	2	Extended Range
Ground Fault	1	None
	2	Standard
	3	Ground Input
Arc Flash Protection	1	No RELT
	2	RELT
Zone Selective Interlocking	1	Short Time and Ground Fault
	2	Short Time, Ground Fault and Instantaneous
Communications	1	None
	2	Modbus
	3	Profibus
Metering	1	Standard (ammeter)
	2	Advanced (A, V, E and P)
	3	Diagnostic (Advanced and WFC)

- Mains and ties in solidly grounded multiple source substations will usually require ground input type ground fault protection. Feeders will use standard internal ground fault protection.

Relay Functions

The EntelliGuard TU offers various protective and alarm relay functions that may be displayed on the LCD screen, assigned contact outputs or communicated serially (Table 3.16).

Protective Relays

Protection relays may be set by the user to alarm, trip the circuit breaker or both. Alarms and trips are displayed on the local LCD trip and communicated serially. Alarms may also be assigned to one of two output contacts. The Trip Alarm settings are independently set for each relay function.

Voltage-Unbalance Relay

This function compares the highest or lowest phase voltage with the average of all three phases and initiates a trip if the difference exceeds the set point. The true RMS voltage is computed for each phase (Table 3.17).

Table 3.17. Voltage Unbalance Settings

Setting	Option
Voltage unbalance pickup	Adjustable from 10% to 50% in increments of 1%.
Voltage unbalance delay	User adjustable from 1sec to 15sec in increments of 1sec. Setting this value to zero (0) will disable the relay.

Table 3.16. Relay Functions Available in EntelliGuard G Circuit Breakers with EntelliGuard TU Trip Units

Functions		Trip	Alarm	Display	Output Contact ²	Serial Comm.	Output ³		
							1	2	Dedicated
Protective	Voltage Unbalance	yes	yes	yes	yes	yes	X	X	-
	Under Voltage	yes	yes	yes	yes	yes	X	X	-
	Over Voltage	yes	yes	yes	yes	yes	X	X	-
	Current Unbalance	yes	yes	yes	yes	yes	X	X	-
	Power Reversal	yes	yes	yes	yes	yes	X	X	-
Status	Current Level Alarm, 2 Settings Available	no	yes	yes	yes	yes	X	X	-
	Health Indication (Bad)	no	yes	yes	yes	yes	X	X	-
	Health Indication (Good)	no	yes	yes	yes	yes	X	X	-
	RELT ON Status ³	no	no	yes	yes	yes	X	-	-
	Ground Fault Alarm Status	no	no	yes	yes	yes	X	X	-
	ZSI Output	no	no	yes	yes	yes	-	-	X
Diagnostics	Trip Target	no	no	yes	no	yes	-	-	-
	Trip Information	no	no	yes	no	yes	-	-	-
	Trip Counter	no	no	yes	no	yes	-	-	-
	Event Logging (Trips, Alarms, I/O)	no	no	yes	no	yes	-	-	-
	Waveform Capture	no	no	yes	no	yes	-	-	-
Metering	Current (Phases A, B, C, N)	no	no	yes	no	yes	-	-	-
	Voltage (Phase A, B, C) ¹	no	no	yes	no	yes	-	-	-
	Energy (kWh, Total)	no	no	yes	no	yes	-	-	-
	Real Power (Watts, Per Phase and Total)	no	no	yes	no	yes	-	-	-
	Apparent Power (Watts, Per Phase and Total)	no	no	yes	no	yes	-	-	-
	Reactive Power	no	no	yes	no	yes	-	-	-

1 User set to PH-N or PH-PH.

2 Output contacts are low signal (Hi-Fi).

3 When top unit has RELT, output 1 is dedicated to RELT ON status.

Current Unbalance Relay

This function compares the true RMS current in the highest or lowest phase with the average of all three phases and initiates a trip if the difference exceeds the set point (Table 3.18).

Table 3.18. Current Unbalance Settings

Item	Options
Current unbalance pickup	Adjustable from 10% to 50% in increments of 1%.
Current unbalance delay setting	User adjustable from 1sec to 15sec in increments of 1sec. Setting this value to zero (0) will disable the relay.

Under Voltage Relay

This function measures the true RMS voltage in all phases and initiates a trip if any phase voltage drops below the set point.

Under Voltage Relay Zero-Volt Trip Enable

This function determines if the relay trips when all three-phase voltages drop to zero volts. Uses the same timing set for the Under-Voltage Relay (Table 3.19).

Table 3.19. Under Voltage Settings

Item	Options
Under voltage pickup	Adjustable from 50% to 90% in increments of 1%.
Under voltage delay setting	User adjustable from 1sec to 15sec in increments of 1sec. Setting this value to zero (0) will disable the relay.

Over Voltage Relay

This function measures the true RMS voltage in all phases and initiates a trip if any phase voltage exceeds the set point. See Table 3.20.

Table 3.20. Over Voltage Settings

Item	Options
Over voltage pickup	User adjustable from 110% to 150% in increments of 1%.
Over voltage delay setting	User adjustable from 1sec to 15sec in increments of 1sec. Setting this value to zero (0) will disable the relay.

Power-Reversal Relay

This function measures the direction of power flow through the breaker and initiates a trip if a sufficient magnitude of reverse power is detected (Table 3.21).

Table 3.21. Power-Reversal Settings

Item	Options
Power reversal pickup	User adjustable from 10 kW to 1990 kW in increments of 10 kW.
Power reversal delay setting	User adjustable from 1sec to 15sec in increments of 1sec. Setting this value to zero (0) will disable the relay.

Power-Direction Setup

This function selects the normal power flow direction for the breaker, either from line to load or from load to line. This direction setup also affects the sign of the normal power metering displays.

Potential Transformer Primary Voltage

Enter the primary voltage rating of the potential transformer. The range of values is 120V to 600V, in 1V increments.

Potential Transformer Connection

Select the appropriate potential transformer connection, either line-to-line (Ph-Ph) or line-to-neutral (Ph-N).

Power Demand Intervals

This function sets the power demand interval, which can be in the range of 5min to 60min, in steps of 5min. This set-point specifies the time interval for power demand averaging. The trip unit calculates a rolling average of breaker power over this time interval.

Current Alarm

The Trip unit provides two types of current alarm: Current Alarm 1 and Current Alarm 2. The current alarm's ON/OFF pickup settings are user adjustable from 0.5 to 1.0 xIn in steps of 0.05. The trip unit does not allow the current alarm OFF set-point to be set above the ON threshold. If the highest measured phase current goes above the current alarm 1 or current alarm 2 ON set-point, and then remains above the set-point for more than 60sec, the output will close if assigned to either of these alarms. If the current falls below the current alarm 1 or current alarm 2 set-point for more than 60sec, the output, if assigned to the current alarm, will open. This is a definite time function with a 60s delay and a 60sec cool down period. Both periods are fixed.

Trip Logic Inputs

The trip unit is able to receive two hardwired input signals. Either can be a 24Vac or Vdc signal. The inputs can be assigned to two main functionalities:

- Reduce Let Thru Energy (RELT) instantaneous protection "ON".
- Breaker "TRIP".

Table 3.22 shows the assignment for the inputs.

Table 3.22. Input Assignments Possible

Input	Assignment	Summary Description
1	OFF	No action taken.
	TRIP	Will cause the circuit breaker to trip.
	RELT	Input causes to unit to use the RELT set-point as long as input is active. Note: RELT must be set to REMOTE at the Trip HMI or via serial communications.
2	OFF	No action taken.
	TRIP	Will cause the circuit breaker to trip.

Outputs for EntelliGuard G Circuit Breakers

The number of outputs available varies by breaker. The EntelliGuard G circuit breaker has three. These outputs are relay contact outputs to secondary disconnect. Each output can be configured per Table 3.23.

Table 3.23. Output Configuration

Function	Summary Description
GF alarm	Closes when GF alarm is activated. Relays 1 or 2.
Over-current trip (GF, INST, LT, ST)	Over-voltage trip closes the relay. Relays 1 or 2.
RELT on	Closes relay when Reduced Let Through Energy Instantaneous pickup setting is enabled. Relays 1 or 2.
Any protective relay	Closes relays when protective the relay is in pickup. Relays 1 or 2.
Current alarm 1	Exceeding current alarm pick-up closes relay. Relays 1 or 2.
Current alarm 2	Exceeding current alarm pick-up closes relay. Relays 1 or 2.
Health status. NO or NC may be assigned to Health OK via serial communication	Relay contact will change state when the Health Monitoring algorithm senses a change. Relays 1 or 2.

Table 3.24. EntelliGuard Trip Unit Summary

Feature	Characteristic	Specification
Protection Curves	I ² T Slopes	22
	I ¹ t Slopes	22
	IEEE MV (2)	no
	IEC MV (2)	no
Neutral	Neutral Over Current Protection	yes
Long Time PU (I _r) and Delays	Pick Up Range	0.5-1.0 (0.05 steps x Plug
	I ¹ t Range Delays at 6 X	0.5sec – 22sec
	I ¹ t Range Delays at 6 X	0.004sec – 3.09 sec
	Long Time Thermal Memory	yes
Short Time Pick and Delays	Pick Up Range	1.5-12X
	ST Delay Band Range (Commit Time)	0.025sec - 0.417sec
	Band Width	55msec
	ST Delay Bands	11 (UL), 17 (IEC)
	I ² T Slopes	3
	I ¹ t Adjustment	with LT pick up
Instantaneous Protection	Adjustable IPU Range (3)	1.5-15X & OFF
	Extended Range Adjustable IPU	1.5-30A & OFF
	Making Current Release	yes
	Override	yes
	Alternate IPU with Remote Enable	yes (RELT IPU)
	Selective Instantaneous	yes

Waveform Capture

When a fault has taken place, it is important to visualize the event. The Waveform Capture option included in the advanced trip unit can track and visualize any fault event. The device tracks eight cycles, four before and four after the event, with resolution of 48 samples per cycle at 60Hz and stores the results in memory. It registers events in all three phases and the neutral. After the event, the waveform is stored in COMTrade format and can be accessed by using the waveform client module of the Enervista software. When the upload into this software is complete, the tripUnit will reset this function and be available to register the next event.

EntelliGuard Trip Unit Summary

Table 3.24 provides an overview of the trip unit features, characteristics and Specifications and accuracy.

Performance Characteristics Graphs

Figure 3.14 through 3.17 depict selected sensor performance characteristics.

Table 3.24. EntelliGuard Trip Unit Summary (continued)

Feature	Characteristic	Specification	Accuracy (at 100%)
Ground Fault Protection	Pick Up Range	0.1/0.2 – 10	-
	External Zero Seq. (Gnd Return) CT Input	1A = 100%	-
	Delay Band Range	0.042/0.058-0.417/0.0917sec	-
	Delay Bands	9/7/2015	-
	I ² t Slopes	2	-
	I ⁴ t Slopes	1	-
	GF Alarm Option	yes	-
Zero Selective Interlock	Short time	yes	-
	Ground Fault	yes	-
	Separate ZSI Band Settings	yes	-
	Instantaneous	yes	-
Protective Relays	Current Unbalanced	10% - 50% difference between highest & lowest phase compared to average, 1% steps; 1 to 15sec delay in 1sec steps	2%, ±0.1sec on delay
	Over Voltage	110% - 115% of line voltage in 1% Steps; 1-15sec delay in 1sec steps	2%, ±0.1sec on delay
	Under Voltage	30% - 85% of line voltage in 1% Steps; 1-15 Second Delay in 1 sec steps	2%, ±0.1sec on delay
	Voltage Unbalance	10% - 50% difference between highest & lowest phase compared to average, 1% steps; 1 to 15sec delay in 1sec steps	2%, ±0.1sec on delay
	Power Reversal	Line to Load OR Load to Line, From 10 to 990kW in 10kW steps	2%
	Current Level (Alarm/Load Management)	2	-
Metering, Diagnostic, and Miscellaneous Functions	Current (A)	A, B, C & neutral	0000 Resolution, 2%
	Voltage (V)	A, B, & C	0000 resolution, 2%
	Real Power (kW)	A, B, C and total	000.000 resolution, 4%
	Reactive Power (KVAR)	A, B, C and total	000.000 resolution, 4%
	Apparent Power (kVA)	A, B, C and total	000.000 resolution, 4%
	Energy (KWh)	A, B, C and total	000.000 resolution, 4%
	Frequency (Hz)	yes	00 resolution, 1 cycle
	Real Demand (kW)	total	000.000 resolution, 4%
	Power Factor (%)	A, B, C	00 resolution, 4%
	Peak Power Demand (KW)	A, B, C	000.000 resolution, 4%
	Waveform Capture (COMTrade)	yes (requires PMCS)	-
	Trip Operations Counter	yes	-
	Temperature Monitoring	future	-
	Event Log	last 10 events	-
Serial Comm.	Open Protocols (13)	Modbus RTU, Profibus DP	-
	Front Port for Local Comm	yes – standard	-
I/O	Programmable Relays	4	-
	Health Monitoring Relay	1	-
Flexibility	Universal Trip Plugs (16)	yes	-
	Adjustable (20%-100%) Trip Plug	yes	-
	Universal Spare Trip Unit	yes	-
	Interchangeable Trip Unit	with = sensor & process	-

Figure 3.14. Long Time Circuit Breaker Characteristics

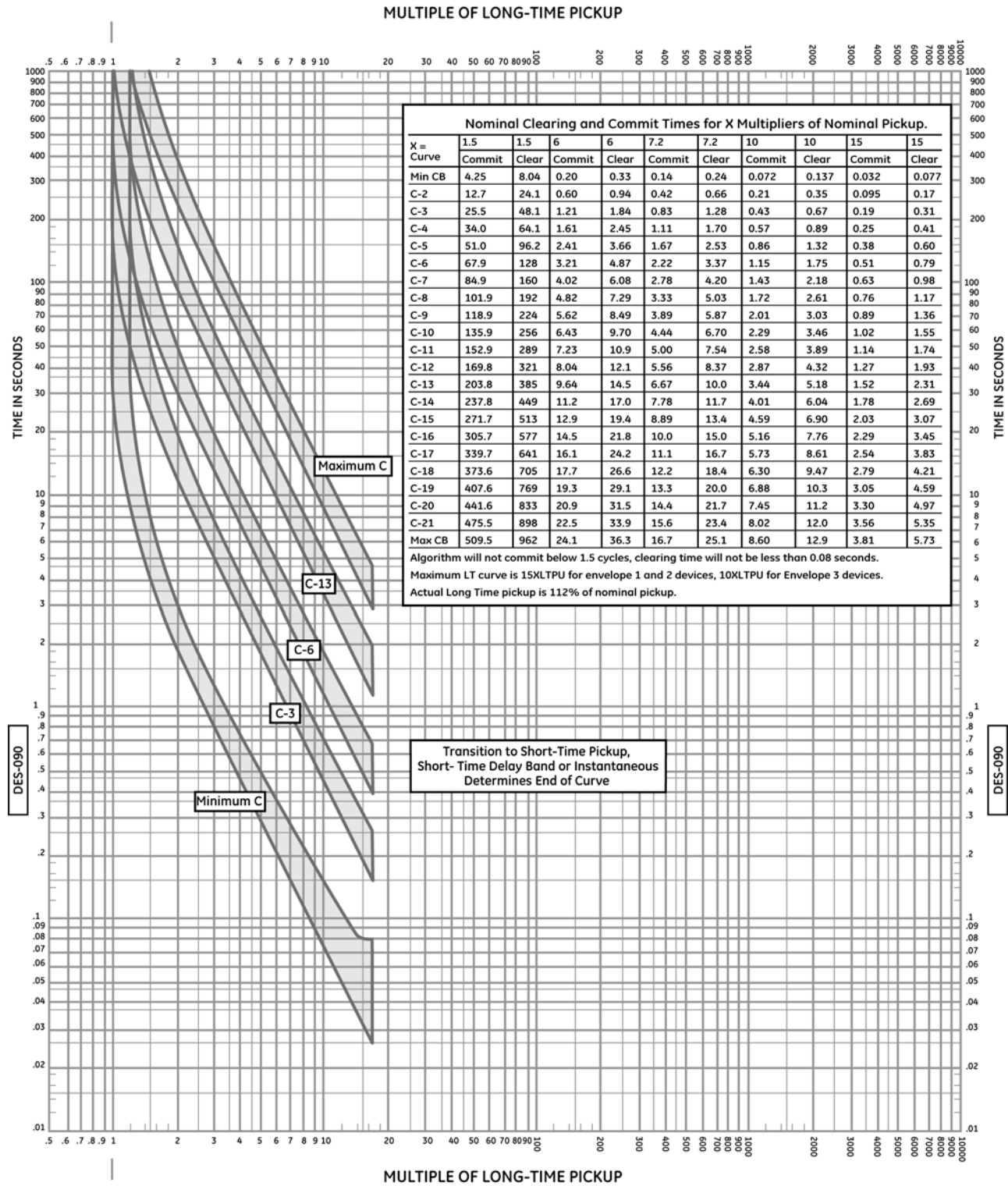


Figure 3.15. Short-Time Pickup and Delay Bands

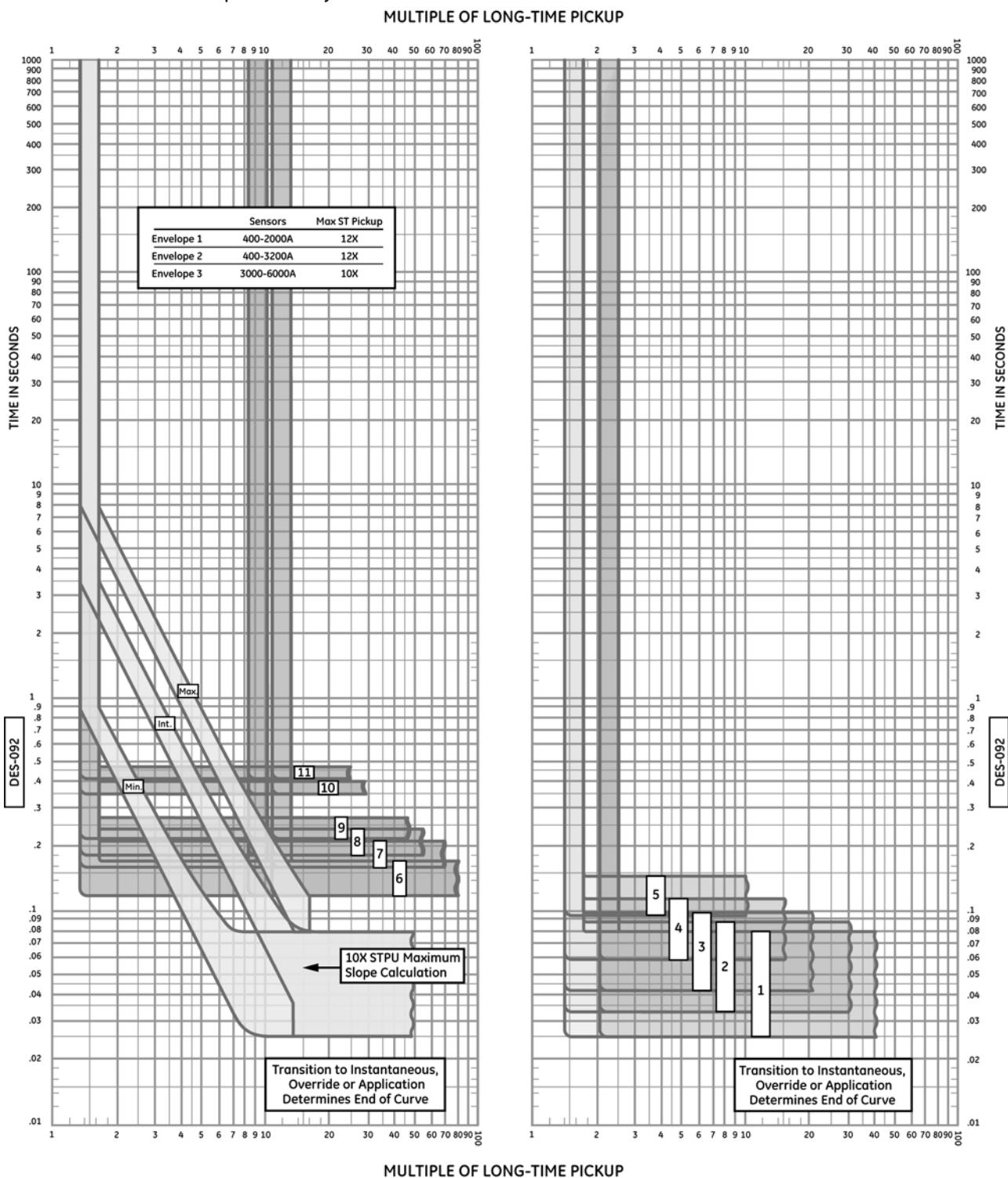


Figure 3.16. Ground Fault: Multiple of Sensor

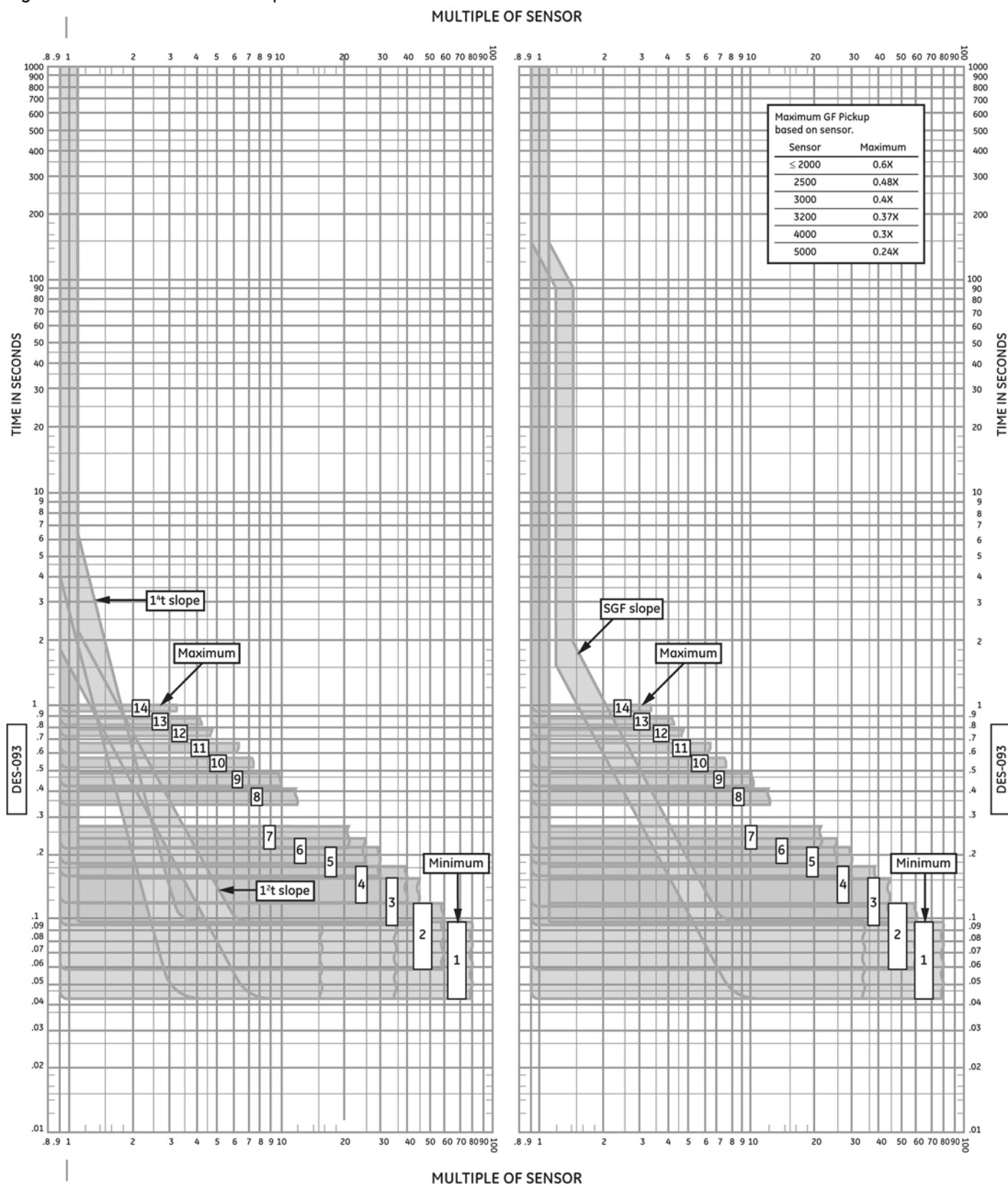
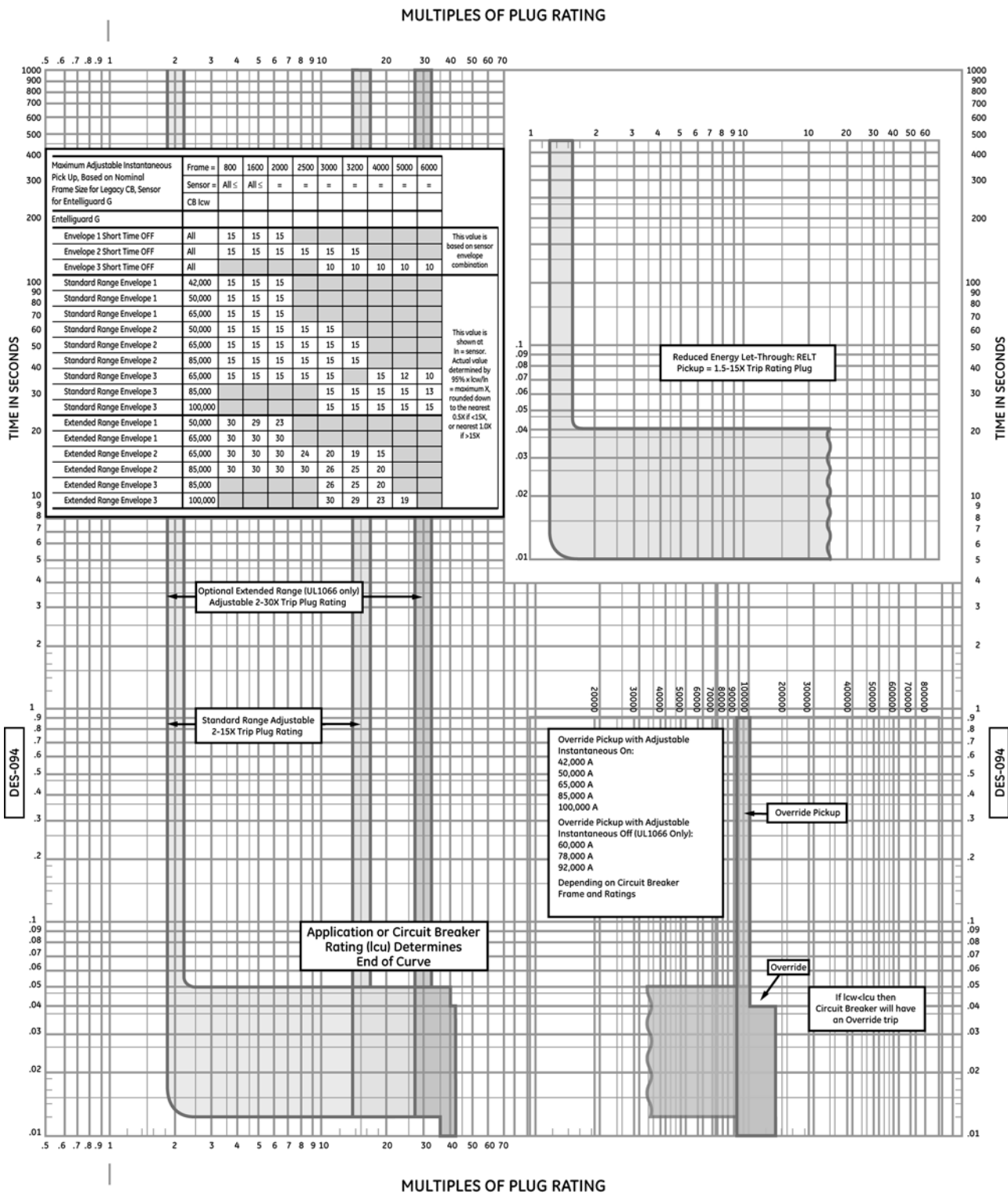


Figure 3.17. Instantaneous, Override (HSIOC), Reduced Energy Let-Through Instantaneous (RELT)



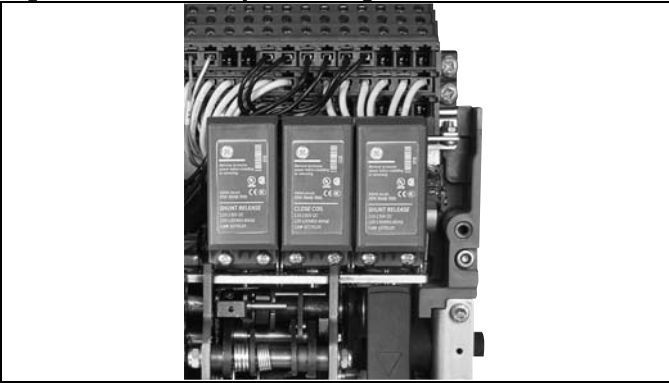
EntelliGuard® G Power Circuit Breaker

Section 4. Accessories

Introduction

A wide range of optional accessories are interchangeable across all EntelliGuard G power circuit breakers, regardless of nominal rating or envelope/frame size. As shown in Figure 4.1, each accessory incorporates easy-fit design features for quick installation, either at the factory or in the field. NOTE: Replacement accessories have an “R” at the end of the catalog number as shown in the tables.

Figure 4.1. Accessory Mounting



Motorized Spring Charging Unit

The unique motor/gearbox unit is specially designed to operate with the full range of EntelliGuard G breakers. It is easily installed with three heavy-duty bolts. After a breaker close operation, the unit automatically recharges the spring and makes it ready for immediate re-close should the need arise. High speed recharging ensures that the springs are fully charged within approximately three seconds following a release. All electrically operated (EO) ANSI/UL breakers are equipped with “Spring Charged” contacts for status indication (Table 4.1).

Circuit Breaker Closing Coils – Standard and Commanded

Two, easy-to-fit, clip-on closing coil options with simple, plug-in connections are available. Both options offer electrical remote release of the spring charged closing mechanism. Both options include a standard anti-pump safety feature ensuring that the close signal must be released before further close commands are allowed. The Command Close Coil additionally provides for local breaker close and remote breaker close over communications via the EntelliGuard Trip Unit (Table 4.2).

Table 4.1 Motor Operators

Envelope	Power Consumption	Nominal Control Voltage	IEC Range (85% to 110%)	ANSI Range	UL Range (85% to 110%)	Cat No.
1	DC – 300W	24Vdc/30Vdc	20.4V to 26.4V	-	20.4V to 26.4V	GM0124DR
		48Vdc	40.8V to 52.87V	38V to 56V	40.8V to 52.87V	GM01048DR
		60Vdc	51V to 66V	-	51V to 66V	GM01060DR
		72Vdc	61.2V to 79.2V	-	61.2V to 79.2V	GM01072DR
		110Vdc/130Vdc	106.25V to 137.5V	100V to 140V	106.25V to 137.5V	GM01130DR
		250Vdc	212.5V to 275V	200V to 280V	212.5V to 275V	GM01250DR
	AC – 350VA	48Vac	40.8V to 52.87V	-	40.8V to 52.87V	GM01048AR
		120Vac	102V to 132V	104V to 127V	102V to 132V	GM01120AR
		240Vac	204V to 264V	208V to 254V	204V to 264V	GM01240AR
		277Vac	235.5V to 304.7V	-	235.5V to 304.7V	GM01277AR
2 and 3	DC – 480W	24Vdc/30Vdc	20.4V to 26.4V	-	20.4V to 26.4V	GM0224DR
		48Vdc	40.8V to 52.87V	38V to 56V	40.8V to 52.87V	GM02048DR
		60Vdc	51V to 66V	-	51V to 66V	GM02060DR
		72Vdc	61.2V to 79.2V	-	61.2V to 79.2V	GM02072DR
		110Vdc/130Vdc	106.25V to 137.5V	100V to 140V	106.25V to 137.5V	GM02130DR
		250Vdc	212.5V to 275V	200V to 280V	212.5V to 275V	GM02250DR
	AC – 560VA	48Vac	40.8V to 52.87V	-	40.8V to 52.87V	GM02048AR
		120Vac	102V to 132V	104V to 127V	102V to 132V	GM02120AR
		240Vac	204V to 264V	208V to 254V	204V to 264V	GM02240AR
		277Vac	235.5V to 304.7V	-	235.5V to 304.7V	GM02277AR

- Spring charge contact is power rated only, as shown below.

AC Ratings		DC Ratings	
Voltage	Amps	Voltage	Amps
110-130V	AC21-15A	24V	DC21-15A
	AC23-10A	110-130V	DC21-10A
220-240V	AC21-10A	250V	DC21-5A
	AC23-5A	-	-

- Spring charge time = 3sec max.
- Recommended fuse amps: contact factory.
- Duty cycle = 2/min.
- Envelope 1 motors: running VA ~ 300VA; inrush = 2 to 3 times.
- Envelope 2 and 3 motors: running VA ~ 450VA; inrush = 2 to 3 times.

Table 4.2. Closing Coil Characteristics

Type	Power Consumption	Nominal Control Voltage	Catalog Number
Closing Coil	DC: 350W, 20 W (sealed)	24Vdc	GCCN024DR
		48Vac/dc	GCCN048R
		60 to 72Vdc	GCCN060DR
	AC: 350W (inrush), 20W (sealed)	110/130/120Vac	GCCN120R
		208Vac	GCCN208AR
		220Vdc/240Vac	GCCN240R
Command Operated Closing Coil	DC: 350W, 20W (sealed)	250Vdc/277Vac	GCCN277R
		24Vdc	GCCC024DR
		48Vac/dc	GCCC048R
	AC: 350W (inrush), 20W (sealed)	60 to 72Vdc	GCCC060DR
		110/130/120Vac	GCCC120R
		208Vac	GCCC208AR

- Duty cycle = 2/min.
- Closing coil inrush = 350VA.

Command Operation Module

This module energizes the closing coil to cause the breaker to close whenever control power is applied to the accessory and when commanded from the breaker trip unit or breaker front panel push button (electrical closing.)

Shunt Trip

Energizing the shunt trip (ST), via local or remote input, will instantaneously activate the circuit breaker mechanism, ensuring a rapid open operation. The shunt trip is continuously rated and does not require an auxiliary switch in series with the coil. The shunt trip is a straightforward, field installable accessory available in wide range of voltages. See Table 4.3.

Table 4.3. Extended Range Shunt Trip for UL Ground Fault and ANSI DC Rating Applications.

Nominal Control Voltage	Catalog Number
24Vdc	GSTG024DR
48Vac/dc	GSTG048R
70/72Vdc	GSTG072DR
110Vdc/120 Vac	GSTG120R
125 Vdc	GSTG125DR
208 Vac	GSTG208AR
240 Vac	GSTG240R
250 Vdc/277 Vac	GSTG277R

- Pickup range = 55%-110%.
- Duty cycle = 2/min.
- Inrush = 480A (ac), 480W (dc).
- Holding = 60VA (ac), 50W (dc).

Status Indication Switch (Coil Signaling Contact)

A plug-in module is available to provide status indication via the secondary disconnects and trip unit. Coil Signaling Contacts are available for closing coils, shunt trips and under voltage releases (Table 4.4). Contact is mounted on top of the Accessory Device. One of the low signal (Hi-Fi) contacts is always wired to the tip Unit.

Table 4.4. Coil Signaling Contact Module

Type and Configuration	Rating			Cat. No.
1 Power rated + 1 Low signal (Hi-Fi) (1NO contact each)	AC	120Vac	6A	GCSP1R
		250Vac	6A	
	DC	125Vac	0.5A	
		250Vdc	0.25A	
	AC	125Vac	0.1A	
	DC	30Vdc	0.1A	
2 Low signal (Hi-Fi) (1NO contact each)	AC	125Vac	0.1A	GCSP2R

Under Voltage Release (UVR) with Fixed Time Delay

The UVR instantaneously activates the circuit breaker trip mechanism when the source voltage drops below the low voltage threshold. The UVR is also a simple, field installable device. NOTE: This accessory acts as a permissive; it is a no-voltage/no-close device. The circuit breaker cannot be closed (manually or electrically) unless the undervoltage release coil is energized above the required threshold. The undervoltage release with fixed time delay is specifically intended for applications where a delay period (ride-through) is required due to potential voltage events. The delays are 50msec when system voltage drops to 50% and 20msec when system voltage drops below 50% (Table 4.5).

Table 4.5. UVR Operating Characteristics

Power Consumption	Nominal Control Voltage	Catalog Number
DC: 350W, 2 W (sealed)	24/30Vdc	GUVT030DR
	40Vdc; 48Vac/dc	GUVT048R
	60Vdc	GUVT060DR
AC: 350W (inrush), 20W (sealed)	110/130/120Vac	GUVT130R
	208Vac	GUVT208AR
	220Vdc/240Vac	GUVT240R
	250Vdc/277Vac	GUVT277R

- Duty cycle = 2/min.
- Inrush = 350VA (ac), 350W (dc).
- Holding = 60VA (ac), 50W (dc).

Time Delay Module (TDM) for UVR (Externally Mounted)

The de-energized operation of the Undervoltage release can be delayed. This optional, externally mounted module has an adjustable time delay of 0 sec to 3 sec. The device can be implemented to prevent undesired breaker tripping due to momentary voltage interruptions and is connected in series with the Undervoltage release. The time delay is in addition to the time delay from the breaker mounted UVR accessory. The time delay module starts counting at 50% of rated voltage (Fig. 4.2 and Table 4.6).

Figure 4.2. Time Delay Module



Table 4.6 TDM Characteristics

Nominal Control Voltage	Catalog No.
48Vdc	GTDM048D
48Vac	GTDM048A
60Vdc	GTDM060D
125Vdc	GTDM120D
120Vac	GTDM120A
208Vac	GTDM208A
240Vdc	GTDM240D
240Vac	GTDM240A
250Vdc	GTDM250D
277Vac	GTDM277A

Remote Operation Coil Combination

Each breaker accepts a maximum of four coils in the combinations shown in Table 4.7. The four positions can be filled by the following four devices: one Close Coil, one Shunt, one UVR, and the final fourth position can either be a Shunt Trip or a UVR. All coils are mounted from the front and snap onto the mechanism after the fascia is removed.

Table 4.7. Remote Operation Coil Combination

Combination	Coil Position on Fascia (from left)			
	1	2	3	4
1	-	shunt	CC	UV
2	shunt	shunt	CC	UV
3	shunt	UV	CC	UV

Ready To Close Contact

These contacts, as shown in Table 4.8, indicate that the following conditions are met and the circuit breaker can be closed:

- The circuit breaker is open.
- The closing springs are charged.
- The circuit breaker is not locked/interlocked in open position.
- There is no standing closing signal.
- There is no standing opening signal.

Table 4.8. Ready To Close Contacts (1 NO)

Rating			Description	Catalog Number
AC	120Vac	6A	high fidelity/secondary disconnect	GRTC2R
	250Vac	6A	-	GRTC2R
DC	125Vdc	0.5A	power rated/secondary disconnect	GRTC1R
	250Vdc	0.25A	high fidelity/trip unit	GRTC3R

Auxiliary Switches

Auxiliary switches indicate breaker main contact position. They change their state in the same time sequence as the breaker main contacts. See Tables 4.9 and 4.10 for available combinations and ratings, and Tables 4.11 through 4.14 for contact information.

Table 4.9. Auxiliary Switches

Contact Configuration	Cat. No.
Power rated (3NO+3NC)	GAUX3R
Power rated (3NO+3NC) + low signal (Hi-Fi) (2NO+2NC)	GAUX5R
Power rated (8NO+8NC)	GAUX6R
Power rated (4NO+4NC) + low signal (Hi-Fi) (4NO+4NC)	GAUX8R

Table 4.10. Auxiliary Switch Ratings and Secondary Disconnect Points

Contact Configuration	Power Rated	Hi-Fi	Cat. No.
Power rated (3NO+3NC)	A14 - A25	N/A	GAUX3R
Power rated (3NO+3NC) + low signal (Hi-Fi) (2NO+2NC)	A14 - A25	B10 - B13, B23 - B26	GAUX5R
Power rated (8NO+8NC)*	A14 - A25, B4 - B13, B17 - B26	N/A	GAUX6R
Power rated (4NO+4NC) + low signal (Hi-Fi) (4NO+4NC)*	A14 - A25, B12 - B13, B25 - B26	B4 - B11, B17 - B24	GAUX8R

*Options are not available for side mounted sec disc blocks.

- High Fidelity refers to gold-plated contacts. Use for signal level outputs (10mA min to 100mA max., 8Vdc to 30Vdc, 125Vac).

Table 4.11. Power Rated (3NO/3NC) (Ref Drawing 10099230)

Normally Open			Normally Closed			
Switch Contact	Secondary Disconnect	Connector	Switch Contact	Secondary Disconnect	Connector	
1	A25	PL1	3	A19	PL2	Power Rated
2	A24		4	A18		
5	A23		7	A17		
6	A22		8	A16		
9	A21		11	A15		
10	A20		12	A14		

Table 4.12. Power Rated (8NO/8NC) (Ref Drawing 10099228)

Normally Open			Normally Closed			
Switch Contact	Secondary Disconnect	Connector	Switch Contact	Secondary Disconnect	Connector	
1	A25	PL1	3	A19	PL5	Power Rated
2	A24		4	A18		
5	A23		7	A17		
6	A22		8	A16		
9	A21		11	A15		
10	A20		12	A14		
13	B26	PL3	15	B13	PL7	
14	B25		16	B12		
17	B24	PL4	19	B11	PL8	
18	B23		20	B10		
21	B22	PL2	23	B9	PL6	
22	B21		24	B8		
25	B20		27	B7		
26	B19		28	B6		
29	B18		31	B5		
30	B17		32	B4		

Table 4.13 Power Rated (3NO/3NC) Low Signal (Hi-Fi) (2NO/2NC) (Ref Drawing 10099232)

Normally Open			Normally Closed			
Switch Contact	Secondary Disconnect	Connector	Switch Contact	Secondary Disconnect	Connector	
1	A25	PL3	3	A19	PL6	Power Rated
2	A24		4	A18		
5	A23		7	A17		
6	A22		8	A16		
9	A21		11	A15		
10	A20		12	A14		
13	B26	PL1	15	B13	PL4	Hi-Fi
14	B25		16	B12		
17	B24	PL2	19	B11	PL5	
18	B23		20	B10		

Table 4.14. Power Rated (4NO/4NC) + Low Signal (Hi-Fi) (4NO/4NC) (Ref Drawing 10099234)

- 15A max. current, 440V max.

Circuit Breaker - Key Interlock Facility

This option supplies factory-installed key interlock mounting provisions (baseplates and mechanism) on the front of the breaker fascia. Key interlocks ensure that a circuit breaker cannot be closed unless the dedicated key has been inserted and secured within the lock. Circuit breakers accept ready-to-fit interlocking device kits such as Castell, Ronis, Kirk and Profalux for installation between related, separate circuit breakers. NOTE: Locks and keys are not supplied by GE. Please order separately from your local supplier (Table 4.15 and Figs. 4.3 and 4.4).

Table 4.15. Key Interlocks and Door Interlocks

Description	Catalog Number
Baseplate and mechanism for Ronis locks (breaker mounted)	GBRONR
Baseplate and mechanism for Kirk Key locks (breaker mounted)	GBKRKR
Mechanism for Ronis key cassette interlock (cassette mounted)	GCRONR
Mechanism for Kirk key cassette interlock (cassette mounted)	GCKRKR
Door interlock (left side)	GLHD
Door interlock (right side)	GRHD

- Kirk Key: Type KCAMXXX10S (Extended), KCAMXXX11S (Withdrawn). S indicates that the key designation (A,B, etc.) is to be stamped on the lock and the key.
- Ronis: Type 1104B lock with standard key, 1/4 in. turn to trap the key, compulsory spindle size.
- For drawout breaker applications, key interlocks can be mounted in the cassette.

Figure 4.3. Breaker-Mounted Key Interlock

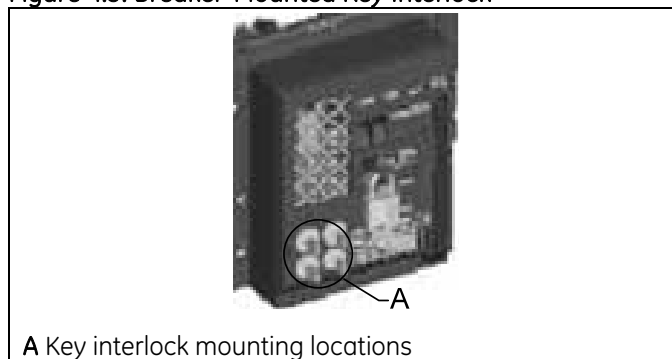
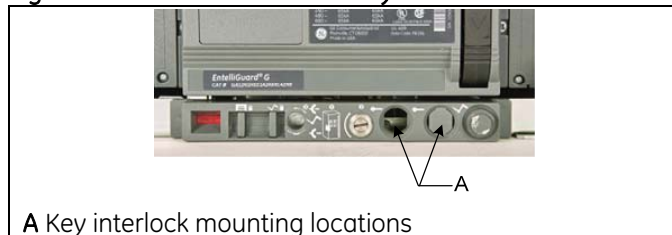


Figure 4.4. Cassette-Mounted Key Interlock



Carriage Position Switch (TOC)

Available as an option for mounting within the base of the cassette/substructure, the carriage position switch provides six single-pole changeover contacts (single pole, double throw) for local or remote electrical indication of the circuit breaker status: CONNECTED, TEST and DISCONNECTED. The DISCONNECTED position is indicated only when minimum isolating distances between contacts on both the main and auxiliary circuits have been achieved. This option is in addition to the mechanical indicators, which are fitted as standard. When installed, the carriage switch is IP2X protected. For use with drawout breakers/cassettes Tables 4.16 and 4.17).

Table 4.16. Carriage Position Switches

Switch Configuration	Catalog Number
1 NO/NC switch per position	GCPS1R
Set of 2 No/NC switches per position	GCPS2R

Table 4.17. Carriage Position Switch Ratings (Common NO/NC Contact Configuration)

Ratings		
AC	120Vac	6A
	250Vac	6A
DC	125Vac	0.5A
	250Vac	0.25A

Mechanical Interlocks (Cable/Rod) (OEM Applications Only)

Available for fixed and draw-out circuit breakers, these units enable the direct interlocking of EntelliGuard G circuit breakers, either mounted side-by-side or stacked. The interlocking mechanisms are connected by a specially designed cable or rod in a 1 from 2, 1 from 3, and 2 from 3 configuration, and any mix of current ratings/pole configurations can be accommodated Table 4.18).

Table 4.18. Mechanical Interlock (Cable/Rod)

Interlock Type	Number of Cables Required	Breaker Type	Poles	Catalog Number
2 Way – Type A	2	withdrawable	3	GI2WADR
			4	GI3WADR
		fixed	3	GI2FADR
			4	GI3FADR
1 from 3 Type B	6	withdrawable	3	GI2WBR
			4	GI3WBR
		fixed	3	GI2FBR
			4	GI3FBR
2 from 3 Type C	6	withdrawable	3	GI2WCR
			4	GI3WCR
		fixed	3	GI2FCR
			4	GI3FCR
1 from 3 Way – Type D	4	withdrawable	3	GI2WDTR
			4	GI3WDTR
		fixed	3	GI2FDTR
			4	GI3FDTR

- Contact factory for availability.

Cables

Standard cable lengths are shown in Table 4.19. (Cables ordered separately. Please contact our technical customer service department if longer length is required.)

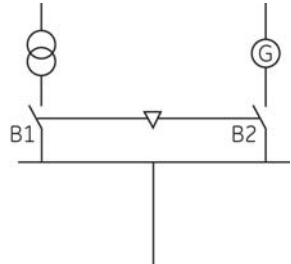
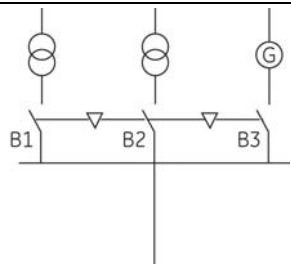
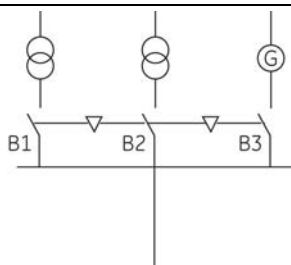
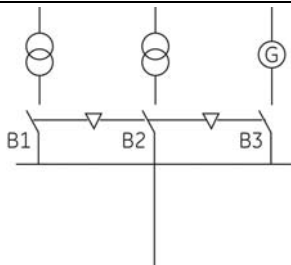
Table 4.19. Cables for Mechanical Interlocks

Length		Catalog Number
Meters	Inches	
1	39.4	GCB1
1.6	63	GCB2
2	78.7	GCB3
2.5	98.4	GCB4
3	118.1	GCB5
3.5	137.8	GCB6
4	157.5	GCB7

- Contact factory for availability.

Mechanical interlocks can be fitted to electrical systems and can link two and/or three circuit breakers. Any nominal rating, frame size, number of poles or type (fixed pattern or draw-out) can be interlocked.

Table 4.20. Interlock Configurations

Typical Circuit	Interlock Configuration	Possible Combinations																								
	Type A 1 from 2 interlock 2 cable configuration Interlocking between two circuit breakers One normal power supply One generator (emergency) supply	<table><tr><th>B1</th><th>B2</th></tr><tr><td>0</td><td>0</td></tr><tr><td>1</td><td>0</td></tr><tr><td>0</td><td>1</td></tr></table> B1 can close only if B2 is open. B2 can close only if B1 is open.	B1	B2	0	0	1	0	0	1																
B1	B2																									
0	0																									
1	0																									
0	1																									
	Type B 1 from 3 interlock 6 cable configuration Interlocking among three circuit breakers Three power supplies (generator or transformers) feeding the same busbar but parallel operation is prevented. Available on request.	<table><tr><th>B1</th><th>B2</th><th>B3</th></tr><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>0</td></tr><tr><td>0</td><td>0</td><td>1</td></tr></table> Only 1 of 3 breakers can be closed.	B1	B2	B3	0	0	0	1	0	0	0	1	0	0	0	1									
B1	B2	B3																								
0	0	0																								
1	0	0																								
0	1	0																								
0	0	1																								
	Type C 2 from 3 interlock 6 cable configuration Interlocking among three circuit breakers Two bus sections can be powered by single transformer (bus tie breaker closed) or both transformers (bus tie breaker open). Available on request.	<table><tr><th>B1</th><th>B2</th><th>B3</th></tr><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</td></tr><tr><td>0</td><td>0</td><td>1</td></tr><tr><td>0</td><td>1</td><td>0</td></tr><tr><td>1</td><td>1</td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td></tr><tr><td>1</td><td>0</td><td>1</td></tr></table> - Any two from three breakers can be closed. - Any one from three breakers can be closed. - Two breakers must be closed to prevent the third breaker from closing.	B1	B2	B3	0	0	0	1	0	0	0	0	1	0	1	0	1	1	0	0	1	1	1	0	1
B1	B2	B3																								
0	0	0																								
1	0	0																								
0	0	1																								
0	1	0																								
1	1	0																								
0	1	1																								
1	0	1																								
	Type D 1 from 3 interlock 6 cable configuration Interlocking between three circuit breakers Two normal power supplies cannot be connected in parallel. One power supply may assist the priority circuit. Available on request.	<table><tr><th>B1</th><th>B2</th><th>B3</th></tr><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</td></tr><tr><td>0</td><td>0</td><td>1</td></tr><tr><td>1</td><td>0</td><td>1</td></tr><tr><td>0</td><td>1</td><td>0</td></tr></table> - B1 and/or B3 can be closed only if B2 is open. - B2 can only be closed if B1 and B2 are both open.	B1	B2	B3	0	0	0	1	0	0	0	0	1	1	0	1	0	1	0						
B1	B2	B3																								
0	0	0																								
1	0	0																								
0	0	1																								
1	0	1																								
0	1	0																								

- Contact factory for availability.

Bell Alarm with Lockout

The Bell Alarm provides remote indication that the circuit breaker has opened because of an electrical fault. The Lockout feature is integral to the trip unit. When a Bell Alarm is supplied with the breaker, the Trip Unit dial is set and locked to the manual position. In order to re-close the breaker, the Lockout button must be pushed in/reset on the Trip Unit 1-Form C contact (Tables 4.21 and 4.22).

Table 4.21. Bell Alarm Switches

Switch Configuration	Cat. No.
One single pole, double throw switch (1-Form C contact)	GBAT1R

Table 4.22. Bell Alarm Ratings (Common 1 NO/NC Contact Configuration)

Ratings		
AC	120Vac	6A
	250Vac	6A
DC	125Vdc	0.5A
	250Vdc	0.25A

Charging Spring Status Indicator

Factory-installed on the motor, this auxiliary switch indicates that the circuit breaker is charged and is standard with the spring-charging motor (Table 4.23).

Table 4.23. Spring Charged Contact (1 NO)

Ratings			Catalog Number
AC	120Vac	6A	GSCC1R
	250Vac	6A	
DC	125Vdc	0.5A	
	250Vdc	0.25A	

Secondary Disconnects (Factory-installed/Field Installable)

Inputs and outputs to the circuit breaker are wired through secondary disconnects located on either the top or the side (Envelope 1 only) of the breaker. The plug-style secondary disconnects engage mating disconnects in the breaker cubicle when the breaker is in the TEST or CONNECT position. Up to 78 points are available so that all breaker accessories can be wired to dedicated disconnect points (Tables 4.24 through 4.29).

Table 4.24. Secondary Disconnect Block Locations

		Top Disconnect	
		Block B	Block A
Side Disconnect	Block A	circuit breaker/cradle viewed from the front	
	Block B		

Table 4.25. Wiring Schematic for Block-A (Three Layer Secondary Disconnect with Basic GTU and Basic Accessories)

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13
	Motor	Motor	Spr NO/ RTC NO	Spr NO/ RTC NO	ST1	ST1	UV1	UV1	CC COM	CC IMM	CC CMD	ST2/ UV2	ST2/ UV2
Max. Current (I)	14.8A	14.8A	10A	10A	1.9A	1.9A	1.9A	1.9A	1.9A	1.9A	1.9A	1.9A	1.9A
Max. Voltage (V)	440V	440V	240V	240V	440V	440V	440V	440V	440V	440V	440V	440V	440V
	A14	A15	A16	A17	A18	A19	A20	A21	A22	A23	A24	A25	A26
	NC3	NC3	NC2	NC2	NC1	NC1	NO3	NO3	NO2	NO2	NO1	NO1	-
Max. Current (I)	15A	15A	15A	15A	15A	15A	15A	15A	15A	15A	1A	15A	-
Max. Voltage (V)	440V	440V	440V	440V	440V	440V	440V	440V	440V	440V	440V	440V	-
	A27	A28	A29	A30	A31	A32	A33	A34	A35	A36	A37	A38	A39
	O/P1a	O/P1b	O/P2a	O/P2b	24 V+	24 V-	BA NC	BA NO	BA COM	N-RC-	N-RC+	Eleg-CT	Eleg-CT
Max. Current (I)	1A	1A	1A	1A	<500mA	<500mA	10A	10A	10A	<50mA	<50mA	5A	5A
Max. Voltage (V)	30Vdc/ 25Vac	30Vdc/ 25Vac	30Vdc/ 25VAC	30Vdc/ 25Vac	30V	30V	240V	240V	240V	480mV	480mV	2V	2V

Table 4.26. Wiring Schematic for Block-B
(Three Layer Secondary Disconnect to be Added for GTU with Full I/O and Additional Accessory Signals)

	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13
	INPUT1	INPUT2	I/P COM	ST1 NO/ NC8	ST1 COM/ NC8	UV1 NO/ NC7	UV1 COM/ NC7	NC6	NC6	NC5	NC5	NC4	NC4
Max. Current (I)	<50mA	<50mA	<50mA	10A/15A	10A/15A	10A/15A	10A/15A	15A	15A	15A	15A	15A	15A
Max. Voltage (V)	30Vdc/ 25Vac	30Vdc/ 25Vac	30Vdc/ 25Vac	240V/ 440V	240V/ 440V	240V/ 440V	240V/ 440V	440V	440V	440V	440V	440V	440V
	B14	B15	B16	B17	B18	B19	B20	B21	B22	B23	B24	B25	B26
	RELT INPUT	COM	-	CC NO/ NO8	CC COM/ NO8	ST2 NO/ UV2 NO/ NO7	ST2 COM/ UV2 COM/ NO7	NO6	NO6	NO5	NO5	NO4	NO4
Max. Current (I)	<50mA	<500mA	-	10A/ 15A	10A/ 15A	10A/ 15A	10A/15A	15A	15A	15A	15A	15A	15 A
Max. Voltage (V)	5V	0.1V	-	240V/ 440V	240V/ 440V	240V/ 440V	240V/ 440V	440V	440V	440V	440V	440V	440V
	B27	B28	B29	B30	B31	B32	B33	B34	B35	B36	B37	B38	B39
	ZSI out+	ZSI out-	ZSI in+	ZSI in-	ISO GND	5V ISO	TX EN 1	RX	TX	GND Volt-IN	Volt-A	Volt-B	Volt-C
Max. Current (I)	<50mA	<50mA	<50mA	<50mA	<500mA	<500 mA	<50mA	<50mA	<50mA	<500mA	<50mA	<50mA	<50mA
Max. Voltage (V)	28Vdc	28Vdc	30Vdc	30Vdc	0.1V	5V	5V	5V	5V	0.1V	1.76V	1.76V	1.76V

Table 4.27. Wiring Schematic for Block-C (Internal to the breaker, not used by customer.)
(Two Layer Intermediate Secondary Disconnect at the Top for the Side Mounted Secondary Disconnect.)

C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21
BA NC	BA NO	BA COM	ST1 NO	ST1 COM	UV1 NO	UV1 COM	CC NO	CC COM	ST2/ UV2 NO	ST2/ UV2 COM	NO5	NO5	NO4	NO4	NC3	NC3	NC2	NC2	NC1	NC1
C22	C23	C24	C25	C26	C27	C28	C29	C30	C31	C32	C33	C34	C35	C36	C37	C38	C39	C40	C41	C42
Spr NO/ RTC NO	Spr NO/ RTC NO	ST1	ST1	UV1	UV1	CC COM	CC IMM	CC CMD	ST2/ UV2	ST2/ UV2	NC5	NC5	NC4	NC4	NO3	NO3	NO2	NO2	NO1	NO1

Table 4.28. Electronic Interlock

Network Interlock Connections								Network Interlock Status Switch		
A5	A6	A7	A8	B4	B5	B6				
NI TRIP	NI TRIP	NI RESET	NI RESET	NI NC	NI NO	NI COM				
1.9A	1.9A	1.9A	1.9A	10A	10A	10A				
240V	240V	240V	240V	240V	240V	240V				

Table 4.29. Wiring Schematic Nomenclature Definitions

Pin	Nomenclature	Description	Pin	Nomenclature	Description
A1	Motor	power input to motor operator	B1	Input 1	relay input to trip unit
A2	Motor		B2	Input 2	relay input to trip unit
A3	SPR NO/RTC NO	spring charge status contact/ ready to close signaling contact	B3	I/P COM	relay input to trip unit
A4	SPR NO/RTC NO		B4	ST1 NO/NC8	shunt trip 1 signaling contact/normally open contact 8
A5	ST1	power input to shunt trip 1	B5	ST1 COM/NC8	
A6	ST1		B6	UV1 NO/NC7	under voltage release 1 signaling contact/normally closed contact 7
A7	UV1	under voltage release 1	B7	UV1 COM/NC7	
A8	UV1		B8	NC6	normally closed contact 6
A9	CC COM	closing coil neutral wire-common (CC or CCC)	B9	NC6	
A10	CC IMM	closing coil (CC), continuous control power (CCC)	B10	NC5	normally closed contact 5
A11	CC CMD	closing coil close signal (CCC)	B11	NC5	
A12	ST2/UV2	power input to shunt trip 2/under voltage release 2	B12	NC4	normally closed contact 4
A13	ST2/UV2		B13	NC4	
A14	NC3	normally closed contact 3	B14	RELT	RELT signal output
A15	NC3		B15	COM	trip unit communication
A16	NC2	normally closed contact 2	B16	-	-
A17	NC2		B17	CC NO/NO8	closing coil signaling contact/normally open contact 8
A18	NC1	normally closed contact 1	B18	CC COM/NO8	
A19	NC1		B19	ST2 NO/UV2 NO/NO7	shunt trip 2 signaling contact/under voltage release 2 signaling contact/ normally open contact 7
A20	NO3	normally open contact 3	B20	ST2 COM/UV2 COM/NO7	
A21	NO3		B21	NO6	normally open contact 6
A22	NO2	normally open contact 2	B22	NO6	
A23	NO2		B23	NO5	normally open contact 5
A24	NO1	normally open contact 1	B24	NO5	
A25	NO1		B25	NO4	normally open contact 4
A26	-	-	B26	NO4	
A27	O/P1a	relay output 1 from trip unit	B27	ZSI out+	GF zone selective interlock output
A28	O/P1b	relay output 1 from trip unit	B28	ZSI out-	
A29	O/P2a	relay output 2 from trip unit	B29	ZSI in+	GF zone selective interlock input
A30	O/P2b	relay output 2 from trip unit	B30	ZSI in-	
A31	24 V+	auxiliary power supply to trip unit	B31	ISO GND	trip unit communication
A32	24 V-		B32	5V Iso	
A33	BA NC	bell alarm switch	B33	TX EN 1	
A34	BA NO		B34	RX	
A35	BA COM		B35	TX	
A36	N-RC-	neutral Rogowski coil	B36	Voltage Input GND	ground point for voltage input to trip unit
A37	N-RC+		B37	Volt-A	system phase voltage signals
A38	Eleg-CT	earth leg CT (multi-source ground fault)	B38	Volt-B	
A39	Eleg-CT		B39	Volt-C	

Ground Fault

The EntelliGuard TU Trip Unit provides a non-core CT input for zero sequence or residual summation current. The expected ratio is 1A = 100%.

Neutral Rogowski

The Neutral Rogowski CT's are used to measure the Neutral Current and is required when Internal Ground Fault is selected on the trip unit. There are two types available:

1. Encased with Terminal Screws: The Rogowski coil is encased with two terminal screws. No additional mounting hardware is required as the encasing is molded to the mounting dimensions. Table 4.30
2. Loose Rogowski Coil with separate mounting hardware: The coil and mounting hardware are separate. The coil comes with the two wire leads for connection to a terminal block. Table 4.30a

**Table 4.30. Neutral Rogowski CTs
(Encased with Terminal Screws)**

Envelope	Current Rating	Cat. No.
1	400 A	G04HNRCE
	600/630 A	G07HNRCE
	800 A	G08HNRCE
	1000 A	G10HNRCE
	1200/1250 A	G13HNRCE
	1600 A	G16HNRCE
	2000 A	G20HNRCE
2	400 A	G04MNRCE
	600/630 A	G07MNRCE
	800 A	G08MNRCE
	1000	G10MNRCE
	1200/1250 A	G13MNRCE
	1600 A	G16MNRCE
	2000 A	G20MNRCE
	2500 A	G25MNRCE
3	3000/3200 A	G32HNRCE
	4000 A	G40HNRCE
	3000/3200 A (1600 A x 2)	G32GNRCE
	4000 A (2000 A x 2)	G40MNRCE
	5000 A (2000 A x 2)	G50MNRCE
	6000/6400 A (3200 A x 2)	G04MNRCE

Table 4.30a. Neutral Rogowski CTs (Loose Rogowski Coil and mounting hardware)

Envelope	Current Rating	Cat. No.
1	400 A	G04HNRC
	600/630 A	G07HNRC
	800 A	G08HNRC
	1000 A	G10HNRC
	1200/1250 A	G13HNRC
	1600 A	G16HNRC
	2000 A	G20HNRC
2	400 A	G04MNRC
	600/630 A	G07MNRC
	800 A	G08MNRC
	1000	G10MNRC
	1200/1250 A	G13MNRC
	1600 A	G16MNRC
	2000 A	G20MNRC
	2500 A	G25MNRC
	3000/3200 A	G32HNRC
3	4000 A	G40HNRC
	3000/3200 A (1600 A x 2)	G32GNRC
	4000 A (2000 A x 2)	G40MNRC
	5000 A (2000 A x 2)	G50MNRC
	6000/6400 A (3200 A x 2)	G04MNRC

Sealed Door Panel Escutcheon

An optional complete IP54 front door panel is available when a higher degree of protection is needed (Table 4.31).

Mechanical Operations Counter

Used with either manual or motor charged circuit breakers, the counter provides an accurate record of the cumulative number of complete breaker closing operations (Table 4.31).

Table 4.31. Miscellaneous Accessories

Description	Cat. No.
IP54 Door Panel - Withdrawable Type	GF54D
IP54 Door Panel - Fixed Pattern	GW54D
Mechanical Operations Counter	GMCNR
ACB Lifting Truck	ACBLIFT

- Contact factory for availability.

Cassette/Substructure

The drawout mechanism allows the breaker to be racked in four distinct positions (CONNECTED, TEST, DISCONNECTED, WITHDRAWN).

Position Indicators

Position indicators provide a positive mechanical indication of CONNECTED, TEST and DISCONNECTED positions of the breaker.

Door Interlocks

See Table 4.32.

Table 4.32. Door Interlocks

Mounting	Catalog Number
Right mounted	GRHDR
Left mounted	GLHDR

Front Flat Terminations

The EntelliGuard G Fixed mounted breaker comes standard with Back Connected Terminations. Optional Front Flat terminations are available for front access mounting (Table 4.33).

Table 4.33. Optional Front Flat Terminations

Description	Catalog Number
Env1 800 - 2000A, Type N&H, Flat Front UL489 Fixed 3 Pole Breaker Bus Bar Terminations (Top/Bottom)	GBB1TBF3
Env1 800 - 2000A, Type N&H, Flat Front UL489 Fixed 4 Pole Breaker Bus Bar Terminations (Top/Bottom)	GBB1TBF4
Env2 800A - 3000A Flat Front UL489 Fixed 3 Pole Breaker Bus Bar Terminations (Top/Bottom)	GBB2TBF3
Env2 800A - 3000A Flat Front UL489 Fixed 4 Pole Breaker Bus Bar Terminations (Top/Bottom)	GBB2TBF4
Env3 4000-6000A Flat Front UL Fixed 3 Pole Breaker Bus Bar Terminations (Top/Bottom)	GBB3TBF3
Env3 4000-6000A Flat Front UL Fixed 4 Pole Breaker Bus Bar Terminations (Top/Bottom)	GBB3TBF4

Grounding/Earthing Device (IEC Only)

All EntelliGuard G circuit breakers can be fitted with a grounding/earthing device, which has a short circuit rating equal to the breaker withstand rating. This permits either the feeder cables or the busbar to be safely grounded and locked during system maintenance operations (Table 4.34).

Table 4.34. Earthing Devices (IEC only)

Envelope	Current Rating	Poles
1	400 to 1600/3P	3
	400 to 1600/4P	4
	2000/3P	3
	2000/4P	4
2	400 to 4000/3P	3
	400 to 4000/4P	4
3	3200 to 6300/3P	3
	3200 to 6300/4P	4

Rejection Device

A factory-installed rejection feature prevents mismatching breakers and cassettes/substructures. This prevents (a) inserting a breaker with a lower rating into a higher rated cassette/substructure and (b) inserting a higher rated breaker into a lower rated cassette/substructure. Mis-insertion Interlock catalog number is GREPM.

EntelliGuard® G Power Circuit Breaker Section 5. Catalog Numbering Guide

EntelliGuard G ANSI/UL489 Circuit Breaker Catalog Number Guide

Sample	G	A	16	M	1	H	E	R	X	5	R	A	X	X	L4	X	6	V
Digit	1	2	3&4	5	6	7	8	9	10	11	12	13	14	15	16&17	18	19	20
	Circuit Breaker Family	Breaker Switch Type	Current Rating Sensors	Short Circuit Withstand Rating	Mounting	Spring Charge Motor	Closing Devices	Shunt Trip	UVR	2nd Shunt Trip, 2nd UVR	Auxiliary Switch, Coil Signaling Contact	Bell Alarm, Mechanical Counter, Trip Annunciation	Key Interlock and Padlock Device	Mechanical Interlock	Overcurrent Protection Ground Fault	ZSI	Advanced Features and Communications	Rating Plug

Digit 1 – Circuit Breaker Family

Device Series/Line	Code
EntelliGuard G Breaker/Switch	G

Digit 2 – Device & Type

Breaker/Switch Type, Secondary Mounting	Envelope 1		Envelopes 2 & 3
	Side	Top	Top
ANSI/UL1066 Circuit Breaker	A	N	A
UL489 Circuit Breaker	B	U	B
ANSI Non-auto CB (ANSI Switch)	C	M	C
UL489 Non-auto CB (UL Switch)	D	S	D

- Top = Top Mounted Secondary Disconnects (TSD).
- Side = Side Mounted Secondary Disconnects (SSD). (Available on Envelope 1 only.)
- N, U, M, S characters are for Envelope 1 only with top mounted secondary disconnects (TSD).
- When ordering codes A, B, C, D, Side Secondary Disconnects (SSD) are supplied as standard on Envelope 1.
- Codes N, U, M, S are not valid for Envelopes 2 & 3.
- Envelope 1 (Type N and H, 400A - 2000A).
- DC Ratings; trip unit not included. DC Rated Circuit Breakers require external control devices (e.g., Type 37 or Type 76 DC Relays).
- Side Secondary Disconnects are specifically intended for 5-High ("high density") equipment designs.
- With Side Mounted Disconnects (SSD), the following aux switches are not valid (In Digit 12): Auxiliary Switch, 8 NO+8 NC (Power Rated) or Aux. Switch, 4 NO/4 NC (Power Rated) + 4 NO/4 NC low signal (Hi-Fi).

Digits 3 & 4 – Current Rating/Sensors

Current Sensor Rating (A)	Circuit Breaker		Switches*	
	ANSI	UL489	ANSI	UL489
400	04	04	-	-
600	-	06	-	-
800	08	08	08	08
1000	-	10	-	-
1200	-	12	-	12
1600	16	16	16	16
2000	20	20	20	20
2500	-	25	-	25
3000	-	30	-	30
3200	32	-	32	-
4000	40	40	40	40
5000	50	50	50	50
6000	-	60	-	60

*Switches (Digit 2 = M, S, C, D) do not have current Sensors or a trip unit.

Digit 5 – EntelliGuard G Short Circuit and Interrupting Ratings														
Interrupting Rating Tier ANSI/UL1066 Devices, LVPCB									Envelope 1		Envelope 2		Envelope 3	
C o d e	240V	480V	600V	1/2S Withstand	HSIOC	Override No. 1	Override W	C o d e	400-2000	3200	400- 3200	3200	4000- 5000	
N	65,000	65,000	65,000	65,000	None	None	None	N	X	X				
H	85,000	85,000	65,000	65,000	65,000	63,700	69,500	H	X					
E	85,000	85,000	85,000	85,000	None	None	None	E			X			
M	100,000	100,000	85,000	85,000	85,000	83,800	90,950	M			X		X	
B	100,000	100,000	100,000	100,000	None	None	None	B				X	X	
L	150,000	150,000	100,000	100,000	100,000	98,000	107,000	L				X	X	
Interrupting Rating Tier UL489 Devices ICCB									Envelope 1		Envelope 2		Envelope 3	
	240V	480V	600V	1/2S Withstand	HSIOC	Override No. 1	Override W		400-2000	2500- 3000	400- 3000	3000	4000	5000- 6000
N	65,000	65,000	65,000	42,000	42,000	N/A	44,940	N	X	X				
H	85,000	85,000	65,000	50,000	50,000	N/A	53,500	H	X	X				
M	100,000	100,000	85,000	65,000	65,000	N/A	69,550	M			X		X	X
L	150,000	150,000	100,000	85,000	85,000	N/A	90,950	L				X	X	X
ANSI Non-Automatic Switches				30 Cycle Withstand Ratings					Envelope 1		Envelope 2		Envelope 3	
	240V	480V	600V	Notes: Non-automatic switches are provided with no internal sensing or tripping mechanism and cannot be applied above their respective withstand levels. If a non-automatic device is required at ratings above the available switches is required, it is recommended that a circuit breaker set with maximum settings be employed using external control or protection as required by the application.					800-2000		800-3200		3200-5000	
N	42,000	42,000	42,000					N <th colspan="2">X</th> <th colspan="2"></th>	X					
M	65,000	65,000	65,000					M <th colspan="2"></th> <th colspan="2">X</th>			X			
B	100,000	100,000	100,000					B <th colspan="2"></th> <th colspan="2">X</th>			X			
UL489 Non-Automatic Switches									Envelope 1		Envelope 2		Envelope 3	
	240V	480V	600V						800-2000		800-3000		3000-6000	
N	42,000	42,000	42,000					N <th colspan="2">X</th> <th colspan="2"></th>	X					
M	65,000	65,000	65,000					M <th colspan="2"></th> <th colspan="2">X</th>			X			
B	100,000	100,000	100,000					B <th colspan="2"></th> <th colspan="2">X</th>			X			

Digit 6 – Mounting Type Poles			
Designation	Mounting	Poles	Code
OEM	drawout	3	1
		4, right	2
		4, left	3
	stationary	3	4
		4, right	5
		4, left	6
GE Equipment	drawout	3	D
	stationary	3	F

- Right, Left indicates the location of the fourth pole, typically used to switch the neutral.
- Stationary and drawout breakers come with back connected terminations. Optional front flat terminations are available. See page 40.

Digit 7 – Spring Charging Motor		
Spring Charging Motor (EO)		Code
DC	24/30Vdc	A
	48Vdc	B
	60Vdc	C
	72Vdc	D
	110/130Vdc	E
	250Vdc	F
AC	48Vac	G
	120Vac	H
	240Vac	J
	277Vac	K
Blank/none*		X

*An "X" (Blank/None) denotes a Manually Operated device (MO) Spring Charge Contact, GSCC1, included with all Motor Operators.

- When a Spring Charging Motor is selected, a Closing Device must be selected from Closing Devices for Digit 8, and a Shunt Trip Device must be selected from Shunt Trip 1 Devices for Digit 9.
- Shunt Trip 1 with a coil voltage different from the Spring Charge Motor may be user-selected.

Digit 8 – Closing Devices		
Closing Coil Type		Code
Closing Coil (CC)*	24Vdc	A
	30Vdc	B
	48Vac/dc	C
	60 – 72Vdc	D
	110Vdc/130Vdc; 120Vac	E
	208Vac	F
	220Vdc; 240Vac	G
Command Operated Closing Coil (CCC)**	250Vdc; 277Vac	H
	24Vdc	M
	30Vdc	N
	48Vac/dc	P
	60 – 72 Vdc	Q
	110Vdc/130Vdc; 120Vac	R
Blank/none	208Vac	S
	220Vdc; 240Vac	T
		X

*The Closing Coil (CC) permits either local or remote release of the spring charged closing mechanism by electrical operation.

**The Command Operated Closing Coil (CCC) includes an additional anti-pumping safety feature to ensure that the electrical closing signal must be released before further closure is attempted, a shut off is initiated if the closing signal is maintained.

- Manual button through breaker cover is included as standard assembly.
- When a Spring Charging Motor is selected (Digit 7), a Closing Device must be selected from Closing Devices for Digit 8, and a Shunt Trip Device must be selected from Shunt Trip 1 Devices for Digit 9.
- **SELECT ONE DEVICE ONLY.**

Digit 9 – Shunt Trip 1	
Extended Range Shunt Trip (ANSI/UL)*	Code
24Vdc	M
48Vac/dc	P
70 – 72Vdc	Q
110/125Vdc; 120Vac	R
208Vac	S
220Vdc; 240Vac	T
250Vdc; 277 Vac	V
Blank/none	X

*The Extended Range Shunt Trip is specifically intended and required for UL ANSI Ground Fault applications. The pick up range is 55-110% of the ST coil voltage.

- When a motor is selected from the Spring Charging Motor (Digit 7) a Shunt Trip 1 must be selected.
- **SELECT ONE DEVICE ONLY.**

Digit 10 – Under Voltage Release (UVR)	
UVR with Fixed Time Delay *	Code
24Vdc	1
30Vdc	2
48Vac/dc	3
60-72Vdc	4
110/130Vdc; 120Vac	5
208Vac	6
220Vdc; 240Vac	7
250Vdc; 277Vac	8
Blank/none	X

*The UVR Shunt Trip with Fixed Time Delay is specifically intended for applications where a delay period ('ride- through') is required due to potential voltage events. The design delays are 50msec when system voltage drops to 50% and 20 msec when system voltage drops below 50%.

- An optional External UVR Time Delay Module is available in a 1 - 3sec delay.
- **SELECT ONE DEVICE ONLY.**

Digit 11 – 2nd Shunt Trip or UVR		
	Type	Code
2nd UVR with Fixed Time Delay **	24Vdc	1
	30Vdc	2
	48Vac/dc	3
	60 - 72Vdc	4
	110Vdc/130Vdc; 120Vac	5
	208Vac	6
	220Vdc; 240Vac	7
2nd Extended Range Shunt Trip (ANSI/UL)*	250Vdc; 277Vac	8
	24Vdc	M
	48Vac/dc	P
	70 - 72Vdc	Q
	110/125Vdc; 120Vac	R
	208Vac	S
Blank/none	240Vac	T
	250Vdc	V
		X

*The Extended Range Shunt Trip is specifically intended and required for UL ANSI Ground Fault applications. The pick up range is 55-110% of the ST coil voltage.

**The UVR with Fixed Time Delay is specifically intended for applications where a delay period ('ride- through') is required due to potential voltage events. The design delays are 50msec when system voltage drops to 50% and 20msec when system voltage drops below 50%.

- An optional External UVR Time Delay Module is available in a 1 - 3sec delay.
- **SELECT ONE DEVICE ONLY.**

Digit 12 – Auxiliary Switch		
Contact Configuration		Code
Auxiliary Switch, 3NO+3NC (Power Rated)* STANDARD/INCLUDED		2
Auxiliary Switch, 8NO+8NC (Power Rated)***		4
Aux. Switch, 3NO/3NC (Power Rated) + 2NO/2NC low signal (Hi-Fi)		6
Aux. Switch, 4NO/4NC (Power Rated) + 4NO/4NC low signal (Hi-Fi)***		8
Auxiliary Switch, 3NO+3NC (Power Rated)	CSC, PR, (1 NO on SD) - Close Coil or CCC	A
	CSC, Hi-Fi via Trip Unit - Close Coil or CCC**	B
	CSC, PR, (1 NO on SD) - 1st Shunt Trip	C
	CSC, Hi-Fi via Trip Unit - 1st Shunt Trip **	D
	CSC, PR, (1 NO on SD) - 1st UVR	E
	CSC, Hi-Fi via Trip Unit - 1st UVR**	F
	CSC, PR, (1 NO on SD) - 2nd ST or 2nd UVR	G
	CSC, Hi-Fi via Trip Unit - 2nd ST or 2nd UVR**	H
Aux. Switch, 3NO/3NC (PR) + 2NO/2NC Low Signal (Hi-Fi)	CSC, PR, (1 NO on SD) - Close Coil or CCC	J
	CSC, Hi-Fi via Trip Unit - Close Coil or CCC**	K
	CSC, PR, (1 NO on SD) - 1st Shunt Trip	L
	CSC, Hi-Fi via Trip Unit - 1st Shunt Trip**	M
	CSC, PR, (1 NO on SD) - 1st UVR	N
	CSC, Hi-Fi via Trip Unit - 1st UVR**	P
	CSC, PR, (1 NO on SD) - 2nd ST or 2nd UVR	Q
	CSC, Hi-Fi via Trip Unit - 2nd ST or 2nd UVR**	R
Auxiliary Switch, 3NO+3NC (Power Rated)	CSC, PR, (1 NO on SD) - All Installed Devices	S
	CSC, Hi-Fi via Trip Unit - All Installed Devices**	T
Aux. Switch, 3NO/3NC (PR) + 2NO/2NC Low Signal (Hi-Fi)	CSC, PR, (1 NO on SD) - All Installed Devices	U
	CSC, Hi-Fi via Trip Unit - All Installed Devices**	V

CCC = Command Operated Close Coil

CSC = Coil Signaling Contact

Hi-Fi = High Fidelity

PR = Power Rated

SD = Secondary Disconnect

*The 3NO/3NC scheme is STANDARD (INCLUDED, CODE 2) and is wired to Secondary Disconnect Block A, all other selections require Secondary Disconnect Block B.

**In order to output the Coil Signaling status Hi-Fi via trip unit (options B, D, F, H, K, M, P, R, T, and V) a communications package must be selected in Advanced Features (Digit 19; options 2, 3, 6, 7, 8, 9). This option requires Secondary Disconnect Block B.

***If a UL or ANSI Switch is selected in Digit 2 (C, D, M, S), the Hi-Fi via Trip Unit options are not valid (options B, D, F, H, K, M, P, R, T, V).

***For Side-mounted Secondary Disconnect Blocks, all options are available EXCEPT options 4 and 8.

- The term "Hi-Fi" refers to gold-plated contacts used for signal level outputs (10mA minimum - 100mA maximum, 5-30Vdc, 125Vac).
- If no devices were selected in Digit 8, 9, 10, 11 (Codes = "X"), then Options A - V are invalid.
- Options A-V are only valid if the corresponding device to be monitored by the Coil Signaling Contact (CSC) is selected in digits 8, 9, 10, 11.

Digit 13 – Bell Alarm/Trip Annunciation	
Bell Alarm and Trip Annunciation	Code
Bell Alarm Contact (1NO/1NC) with Lockout (BACL)	A
Mechanical Operations Counter (MOC)	B
Bell Alarm Contact (1NO/1NC) with Lockout and MOC	C
RTC Power Rated Contacts on SD*	1
RTC Signal Rated (Hi-Fi) Contacts on SD*	2
RTC Signal Rated (Hi-Fi) Contacts through Trip Unit**	3
BACL and RTC Power Rated Contacts on SD*	D
BACL and RTC Signal Rated (Hi-Fi) Contacts on SD*	E
BACL and RTC Signal Rated (Hi-Fi) through Trip Unit**	F
BACL, MOC and RTC Power Rated on SD*	G
BACL, MOC and RTC Signal Rated on SD*	H
BACL, MOC and RTC Signal Rated (Hi-Fi) through Trip Unit**	J
MOC and RTC Power Rated on SD*	K
MOC and RTC Signal Rated on SD*	L
MOC and RTC Signal Rated (Hi-Fi) through Trip Unit**	M
Blank/none	X

BACL = Bell Alarm Contact with Lockout Hi-Fi = High Fidelity
RTC = Ready To Close Contacts SD = Secondary Disconnect

**In order to output the RTC contact output via Trip Unit (options 3, F, J, M) a communications package must be selected in Advanced Features (Code 19/Step 16); this requires Secondary Disconnect Block B.

**If a UL or ANSI Switch is selected, the (Hi-Fi Through Trip Unit) is not valid (Options 3, F, J, M).

**RTC Through the Trip Unit is not a valid option for Switches. Bell Alarm Contact with Lockout comes with the Trip Unit set to Manual LO Enabled.

- The term "Hi-Fi" refers to gold-plated contacts use for signal level outputs (10mA minimum - 100mA maximum, 5-30Vdc, 125vac).
- Option "B", "I", "2", "3", "K", "L", "M", and "X" are the only valid options when a Switch is selected in Digit 2.

Digit 14 – Key Interlock	
Key Interlock (Breaker Mounted)	Code
Castell Key Interlock	C
Kirk Key Interlock	K
Ronis Key Interlock	R
Pushbutton Padlock Device	L
Castell Key Interlock and Push Button Padlock Device	1
Kirk Key Interlock and Push Button Padlock Device	2
Ronis Key Interlock and Push Button Padlock Device	3
Blank/none	X

- This option provides factory installed interlocking devices for installation between separate circuit breakers (baseplates and mechanism). This safeguard ensures that a circuit breaker cannot be closed unless the dedicated key has been inserted and secured within the lock.
- If selecting a Draw Out Breaker (Digit 6), consider putting the Key Interlock on the Cassette versus the breaker. This enables the ability to swap breakers without having to change the key interlocks.
- **Locks and Keys are NOT Supplied by GE.**

Digit 15 – Mechanical Interlocks	
Mechanical Interlocks	Code
Blank/None DEFAULT	X
Mechanical Interlock - Type A	1
Mechanical Interlock - Type B	2
Mechanical Interlock - Type C	3
Mechanical Interlock - Type D	4

- Some installations use multiple power sources that are required to supply energy simultaneously, alternately, or, in a specified sequence. EntelliGuard G Circuit Breakers can be used to interconnect these sources and be electrically and mechanically interlocked to provide the necessary transition and protection. Mechanical Interlocks are available for fixed and draw out circuit breakers. The interlocks enable directly interlocking breakers that are mounted side by side or in vertical stacks. The interlocks consist of two components: (A) The factory-installed bracket fitted to the breaker (fixed breakers) or the cassette (drawout breakers), and (B) The field-installable interconnecting cables available in lengths of 1.0, 1.6, 2.0, 2.5, 3.0, 3.5 and 4.0m (ordered separately). Refer to Section 4 for interlocking schemes.
- Contact factory for availability.

Digits 16 & 17 – Overcurrent Protection Package			
Type		Over Current (OC) Protection Package	Code
EntelliGuard G ANSI/UL OC Protection	Standard Range Instantaneous	LSI (S, switchable) (I, switchable ANSI only)	L3
		LSIG (S, switchable) (I, switchable ANSI only)	L4
		LSIGA (S, switchable) (I, switchable ANSI only) (G, Alarm Only)	L5
		LSIC (S, switchable) (I, switchable ANSI only)	L6
		LSICA (S, switchable) (I, switchable ANSI only) (C, Alarm Only)	L7
		LSIGDA* (S, G, A switchable) (I, switchable ANSI only)	L8
		LSIGCDA* (S, G, C, A all switchable) (I, switchable ANSI only)	L9
	Extended Range Adjustable Instantaneous	LSH (S, switchable) (I, switchable ANSI only)	LC
		LSHG (S, switchable) (I, switchable ANSI only)	LD
		LSHGA (S, switchable) (I, switchable ANSI only) (G, Alarm Only)	LE
		LSHC (S, switchable) (I, switchable ANSI only)	LF
		LSHCA (S, switchable) (I, switchable ANSI only) (C, Alarm Only)	LG
		LSHGDA* (S, G, A switchable) (I, switchable ANSI only)	LH
		LSHGCDA* (S, G, C, A all switchable) (I, switchable ANSI only)	LK
EntelliGuard G ANSI/UL OC Protection with Fuse Settings	Standard Range Instantaneous	JSI (S, switchable) (I, switchable ANSI only)	J3
		JSIG (S, switchable) (I, switchable ANSI only)	J4
		JSIGA (S, switchable) (I, switchable ANSI only) (G, Alarm Only)	J5
		JSIC (S, switchable) (I, switchable ANSI only)	J6
		JSICA (S, switchable) (I, switchable ANSI only) (C, Alarm Only)	J7
		JSIGDA* (S, G, A all switchable) (I, switchable ANSI only)	J8
		JSIGCDA* (S, G, C, A all switchable) (I, switchable ANSI only)	J9
	Extended Range Adjustable Instantaneous	JSH (S, switchable) (H, switchable ANSI only)	JC
		JSHG (S, switchable) (H, switchable ANSI only)	JD
		JSHGA (S, switchable) (H, switchable ANSI only) (G, Alarm Only)	JE
		JSHC (S, switchable) (H, switchable ANSI only)	JF
		JSHCA (S, switchable) (H, switchable ANSI only) (C, Alarm Only)	JG
		JSHGDA* (S, G, A all switchable) (H, switchable ANSI only)	JH
		JSHGCDA* (S, G, C, A all switchable) (H, switchable ANSI only)	JK
NONE - (For Switch Only)		XX	

A = Ground Fault, External Ground Fault, Alarm only

C = External CT for ground fault detection (AKD20 application: input from external summing CTs, used for multiple source ground fault detection. OEM application: Zero Sequence Input of 1A = 100%)

D = Defeatable/Switchable Ground Fault, not UL Listed

G = Ground Fault Protection (GFP, 3-wire or 4-wire, internal summing)

H = Extended Range Adjustable Instantaneous, (IOC, 2x-30x), not available in UL489 version of EntelliGuard G or any Legacy CB

I = Standard Range Adjustable Instantaneous, (IOC, 2x-15x)

J = Long Time (L, I²T) + Fuse Settings (I4T)

L = Long Time (I²T, all trip unit)

S = Short Time (Switchable if Instantaneous (I) protection is enabled)

CA = External Ground Fault Alarm Only

GA = Ground Fault Alarm Only

GDA, GCDA = Ground Fault Trip and Ground Fault Alarm (all switchable, not UL Listed)

*Function Combination is NOT UL Listed.

- Option "XX" is the only valid option when a Switch is selected in Digit 2.

Digit 18 – Zone Selective Interlocking (ZSI)	
Zone Selective Interlocking	Code
ZSI, Short time and GF; user selectable	Z
Z + IOC or HIOC ZSI; user selectable	T
Blank/none	X

- ZSI selections require Secondary Disconnect Block B and 24Vdc control power. Control power recommended for instantaneous ZSI.

Digit 19 – Advanced Features and Communications	
Advanced Features and Communications	Code
Reduced Energy Let-Through (RELT)	1
Modbus Protocol + RELT	2
Profibus Protocol + RELT	3
Monitoring + RELT, NO Communication	4
Monitoring + Relay Package + RELT	5
Monitoring + Data Acquisition, Modbus Protocol + RELT	6
Monitoring + Data Acquisition, Profibus Protocol + RELT	7
Monitoring + Data Acquisition + Relay Package, Modbus + RELT	8
Monitoring + Data Acquisition + Relay Package, Profibus + RELT	9
None	X

- All Advanced Feature selections require Secondary Disconnect Block B and 24Vdc control Power.
- Option "X" is the only valid option when a Switch is selected in Digit 2.
- RELT = Reduced Energy Let Through, requires dedicated input and output on the CB Monitoring = Advanced Metering.
- Data Acquisition = Waveform Capture and Harmonic Analysis.
- In order to output the Coil Signaling status HiFi via trip unit (Digit 12, Options B, D, F, H, K, M, P, R, T, and V) a communications package must be selected in Advanced Features (Digit 19; options 2, 3, 7, 8, 9). This option requires Secondary Disconnect Block B.
- In order to output the RTC contact output via Trip Unit (Digit 13; Options 3, F, J, M) a communications package must be selected in Advanced Features (Code 19/Step 16); this requires Secondary Disconnect Block B.

Digit 20 – Rating Plug		
Rating Plug	Catalog Number	Code
150	GTP0150U0404	A
200	GTP0200U0404	B
225	GTP0225U0406	C
250	GTP0250U0407	D
300	GTP0300U0408	E
350	GTP0350U0408	F
400	GTP0400U0410	G
450	GTP0450U0612	H
500	GTP0500U0613	I
600	GTP0600U0616	J
700	GTP0700U0816	L
750	GTP0750U0820	M
800	GTP0800U0820	N
900	GTP0900U1020	O
1000	GTP1000U1025	P
1100	GTP1100U1225	Q
1200	GTP1200U1232	R
1500	GTP1500U1640	T
1600	GTP1600U1640	U
1900	GTP1900U2050	V
2000	GTP2000U2050	W
2200	GTP2200U2550	Y
2400	GTP2400U2564	Z
2500	GTP2500U2564	1
3000	GTP3000U3064	2
3200	GTP3200U3264	3
3600	GTP3600U4064	4
4000	GTP4000U4064	5
5000	GTP5000U5064	6
6000	GTP6000U6064	7
Rating plug not required/non auto. switch		X

- See Section 3 for further details on rating plugs and sensors.
- Option "X" is the only valid option when a switch is selected in Digit 2.

EntelliGuard G Cassette Catalog Number Guide

Sample	G	A	16	M	2	S
Digit	1	2	3&4	5	6	7
	Circuit Breaker Cassette Family	Breaker Switch Type	Current Rating	Cassette AIC Rating	# of Poles	Shutters

Digit 3 & 4 – Cassette Current Rating		
Current Rating (A)	Circuit Breaker	
	ANSI	UL489
800	08	08
1600	16	16
2000	20	20
3000	-	30
3200	32	-
5000	50	-
6000	-	60

- Select Current Rating equal to or the next higher of the Circuit Breaker or Switch Current Rating

Digit 1 – Cassette Family	
Device Series/Line	Code
EntelliGuard G Breaker/Switch	G

Digit 2 – Cassette Device & Type			
Cassette Type, Secondary Mounting	Envelope 1		Envelopes 2 & 3
	Side	Top	Top
ANSI/UL1066 Circuit Breaker	A	N	A
UL489 Circuit Breaker	B	U	B
ANSI Non-auto CB (ANSI Switch)	C	M	C
UL489 Non-auto CB (UL Switch)	D	S	D

- Top = Top Mounted Secondary Disconnects (TSD).
- Side = Side Mounted Secondary Disconnects (SSD). (Available on Envelope 1 only.)
- N, U, M, S characters are for Envelope 1 only with top mounted secondary disconnects (TSD).
- When ordering codes A, B, C, D, Side Secondary Disconnects (SSD) are supplied as standard on Envelope 1.
- Codes N, U, M, S are not valid for Envelopes 2 & 3.
- Envelope 1 (Type N and H, 400A - 2000A).
- DC Ratings; trip unit not included. DC Rated Circuit Breakers require external control devices (e.g., Type 37 or Type 76 DC Relays).
- Side Secondary Disconnects are specifically intended for 5-High ("high density") equipment designs.
- With Side Mounted Disconnects (SSD), the following aux switches are not valid (In Digit 12): Auxiliary Switch, 8 NO+8 NC (Power Rated) or Aux. Switch, 4 NO/4 NC (Power Rated) + 4 NO/4 NC low signal (Hi-Fi).

Digit 5 – Cassette Envelope Size														
Interrupting Rating Tier ANSI/UL1066 Devices, LVPCB									Envelope 1		Envelope 2		Envelope 3	
	240V	480V	600V	1/2S Withstand	HSIOC	Override No. 1	Override WI		400-2000	3200	400- 3200	3200	4000- 5000	
N	65,000	65,000	65,000	65,000	none	none	none	N	X	X				
H	85,000	85,000	65,000	65,000	65,000	63,700	69,500	H	X					
E	85,000	85,000	85,000	85,000	none	none	None	E			X			
M	100,000	100,000	85,000	85,000	85,000	83,800	90,950	M			X		X	
B	100,000	100,000	100,000	100,000	none	none	none	B				X	X	
L	150,000	150,000	100,000	100,000	100,000	98,000	107,000	L				X	X	
Interrupting Rating Tier UL489 Devices ICCB									Envelope 1		Envelope 2		Envelope 3	
	240V	480V	600V	1/2S Withstand	HSIOC	Override No. 1	Override WI		400-2000	2500- 3000	400- 3000	3000	4000	5000- 6000
N	65,000	65,000	65,000	42,000	42,000	N/A	44,940	N	X	X				
H	85,000	85,000	65,000	50,000	50,000	N/A	53,500	H	X	X				
M	100,000	100,000	85,000	65,000	65,000	N/A	69,550	M			X		X	X
L	150,000	150,000	100,000	85,000	85,000	N/A	90,950	L				X	X	X
ANSI Non-Automatic Switches				30 Cycle Withstand Ratings					Envelope 1	Envelope 2		Envelope 3		
	240V	480V	600V	Notes: Non-automatic switches are provided with no internal sensing or tripping mechanism and cannot be applied above their respective withstand levels. If a non-automatic device is required at ratings above the available switches is required, it is recommended that a circuit breaker set with maximum settings be employed using external control or protection as required by the application.					800-2000	800-3200		3200-5000		
N	42,000	42,000	42,000					N	X					
M	65,000	65,000	65,000					M		X				
B	100,000	100,000	100,000					B		X				
UL489 Non-Automatic Switches									Envelope 1	Envelope 2		Envelope 3		
	240V	480V	600V						800-2000	800-3000		3000-6000		
N	42,000	42,000	42,000					N	X					
M	65,000	65,000	65,000					M		X				
B	100,000	100,000	100,000					B				X		

Digit 6 - Cassette Type & Number of Poles	
Device Series/Line	Code
OEM Cassette – 3 Pole	2
OEM Cassette – 4 Pole	5
GE Equipment Cassette – 3 Pole*	7

*GE Equipment cassette designed specifically for AKD20 Switchgear. These cassettes are NOT available for OEMs.

Digit 7 - Shutter	
Shutters with Locks	Code
Shutter and Shutter Lock - Factory Installed	S
None	X

Loose Cassette Parts – Field Installed	
Carriage Position Switch - 1 NO/1NC	GCPS1R
Carriage Position Switch - 2 NO/2NC	GCPS2R
1 Kirk Key Interlock Cam for Cassette	GCKRKR
1 Ronis Key Interlock Cam for Cassette	GCRONR
Secondary Disconnect Block B, 39 Pole - Top Mounted	GSDWTR
Secondary Disconnect Block B, 39 Pole - Side Mounted	GSDWSR

- Secondary Disconnect Block B is required when:
 - Any "ZONE SELECTIVE INTERLOCKING" options are selected in breaker/trip unit Catalog Digit 18.
 - Any "ADVANCED FEATURES" are selected in breaker/trip unit Catalog Digit 19.
 - A COIL SIGNALING CONTACT OPTION is selected, Digit 12.
 - A READY TO CLOSE signal via the trip unit is selected, Digit 13.
 - Any of the following OPTIONAL Aux. Contact Switches are selected in Digit 12:
 - 8NO/NC POWER RATED
 - 3NO/NC POWER RATED + 2NO/NC Hi-Fi
 - 4NO/NC POWER RATED + 4NO/NC Hi-Fi

EntelliGuard TU Trip Unit for EntelliGuard G Breakers

Sample	GG	M	16	L4	X	6	A	XXXX
Digit	1&2	3	4&5	6&7	8	9	10	11-14
	EntelliGuard Trip Unit Form	Frame Rating	Sensor Rating	Overcurrent Ground Fault Protection	ZSI	Adv. Features and Comm.	Manual Auto Trip Reset	Future Use

Digit 1 & 2 – Trip Unit Form/Family

Circuit Breaker Type	Code
Power Break 1 (UL)	GA
Power Break 2 (UL)	GB
AKR (ANSI)	GC
WP (ANSI)	GW
Mpact Low (IEC)	GL
Mpact 24-48V (IEC)	GH
Mpact 120-240V (IEC)	GQ
Entelliguard G ACB (ANSI)	GG
Entelliguard G ACB (UL)	GU
Entelliguard G ACB (IEC)	GT
EntelliGuard G Universal Spare Trip	G1
Type A Conversion Kits (ANSI)	G2
Entelliguard G Switch (IEC)	G3

- This Application Guide documents the EntelliGuard TU Trip Unit for EntelliGuard G Circuit Breakers.
- GE Legacy ANSI, UL Circuit Breakers are documented in DEH-4567.

Digit 4 & 5 – Sensor Rating

Sensor Rating	Code
UNIV*	00
400	04
600**	06
800	08
1000**	10
1200**	12
1600	16
2000	20
2500**	25
3000**	30
3200***	32
4000	40
5000	50
6000**	60

*Universal Spare Trip Unit.

**UL only.

***ANSI only.

Digit 3 – EntelliGuard G Frame Rating

Code	240V	480V	600V	1/2S Withstand	HSIOC	Override No 1	Override WI
Interrupting Rating Tier, ANSI/UL1066 Devices LVPCB							
N	65,000	65,000	65,000	65,000	none	none	none
H	85,000	85,000	65,000	65,000	65,000	63,700	69,550
E	85,000	85,000	85,000	85,000	none	none	none
M	100,000	100,000	85,000	85,000	85,000	83,300	90,950
B	100,000	100,000	100,000	100,000	none	none	none
L	150,000	150,000	100,000	100,000	100,000	98,000	107,000
Interrupting Rating Tier, UL489 Devices ICCB							
N	65,000	65,000	65,000	42,000	42,000	N/A	44,940
H	85,000	85,000	65,000	50,000	50,000	N/A	53,500
M	100,000	100,000	85,000	65,000	65,000	N/A	69,550
L	150,000	150,000	100,000	85,000	85,000	N/A	90,950

- Refer to GEH-4567 for other circuit breaker types.
- Code E and B is for ANSI EntelliGuard G circuit breakers only.

Digits 6 & 7 – Overcurrent Protection Package (for EntelliGuard® G Breakers)		
Type	Over Current (OC) Protection Package	Code
EntelliGuard G ANSI/UL OC Protection	LSI (S, switchable) (I, switchable ANSI only)	L3
	LSIG (S, switchable) (I, switchable ANSI only)	L4
	LSIGA (S, switchable) (I, switchable ANSI only) (G, Alarm Only)	L5
	LSIC (S, switchable) (I, switchable ANSI only)	L6
	LSICA (S, switchable) (I, switchable ANSI only) (C, Alarm Only)	L7
	LSIGDA* (S, G, A switchable) (I, switchable ANSI only)	L8
	LSIGCDA* (S, G, C, A all switchable) (I, switchable ANSI only)	L9
	LSH (S, switchable) (I, switchable ANSI only)	LC
	LSHG (S, switchable) (I, switchable ANSI only)	LD
	LSHGA (S, switchable) (I, switchable ANSI only) (G, Alarm Only)	LE
	LSHC (S, switchable) (I, switchable ANSI only)	LF
	LSHCA (S, switchable) (I, switchable ANSI only) (C, Alarm Only)	LG
	LSHGDA* (S, G, A switchable) (I, switchable ANSI only)	LH
	LSHGCDA* (S, G, C, A all switchable) (I, switchable ANSI only)	LK
EntelliGuard G ANSI/UL OC Protection with Fuse Settings	JSI (S, switchable) (I, switchable ANSI only)	J3
	JSIG (S, switchable) (I, switchable ANSI only)	J4
	JSIGA (S, switchable) (I, switchable ANSI only) (G, Alarm Only)	J5
	JSIC (S, switchable) (I, switchable ANSI only)	J6
	JSICA (S, switchable) (I, switchable ANSI only) (C, Alarm Only)	J7
	JSIGDA* (S, G, A all switchable) (I, switchable ANSI only)	J8
	JSIGCDA* (S, G, C, A all switchable) (I, switchable ANSI only)	J9
	JSH (S, switchable) (H, switchable ANSI only)	JC
	JSHG (S, switchable) (H, switchable ANSI only)	JD
	JSHGA (S, switchable) (H, switchable ANSI only) (G, Alarm Only)	JE
	JSHC (S, switchable) (H, switchable ANSI only)	JF
	JSHCA (S, switchable) (H, switchable ANSI only) (C, Alarm Only)	JG
	JSHGDA* (S, G, A all switchable) (H, switchable ANSI only)	JH
	JSHGCDA* (S, G, C, A all switchable) (H, switchable ANSI only)	JK
None (for switch only)		XX

A = Ground Fault, External Ground Fault, Alarm only.

C = External CT for ground fault detection (AKD20 application: input from external summing CTs, used for multiple source ground fault detection. OEM Application: Zero Sequence Input of 1A = 100%).

D = Defeatable/Switchable Ground Fault NOT UL Listed.

G = Ground Fault Protection (GFP, 3-wire or 4-wire, internal summing).

H = Extended Range Adjustable Instantaneous, (IOC, 2x-30x), Only for ANSI EntelliGuard G.

I = Standard Range Adjustable Instantaneous, (IOC, 2x-15x).

J = Long Time (L, I²t) + Fuse Settings (I⁴t).

L = Long Time (I²t, all trip unit).

S = Short Time (Switchable if Instantaneous (I) protection is enabled).

GA = Ground Fault Alarm only.

CA = External Ground Fault Alarm only.

GDA, GCDA = Ground Fault Trip and Ground Fault Alarm (all switchable, Not UL Listed).

*Function combination is NOT UL Listed.

Digit 8 – Zone Selective Interlocking (ZSI)	
Zone Selective Interlocking	Code
ZSI, Short time and GF; user selectable	Z
Z + IOC or HIOC ZSI; user selectable	T
Blank/None	X

- ALL ZSI selections require Secondary Disconnect Block B and 24Vdc control power.
- Control power recommended for instantaneous ZSI.

Digit 9 – Advanced Features and Communications	
Advanced Features & Communications	Code
Reduced Energy Let-Through (RELT)	1
Modbus Protocol + RELT	2
Profibus Protocol + RELT	3
Monitoring + RELT, NO Communication	4
Monitoring + Relay Package + RELT	5
Monitoring + Data Acquisition, Modbus Protocol + RELT	6
Monitoring + Data Acquisition, Profibus Protocol + RELT	7
Monitoring + Data Acquisition + Relay Package, Modbus + RELT	8
Monitoring + Data Acquisition + Relay Package, Profibus + RELT	9
None	X

- All Advanced Feature selections require Secondary Disconnect Block B and 24Vdc control Power.
- RELT = Reduced Energy Let Through.
- Monitoring = Advanced Metering.
- Data Acquisition = Waveform Capture and Harmonic Analysis.

Digit 10 – Manual/Auto Trip Reset	
Manual Auto Trip Reset	Code
Manual Lockout	M
Auto Reset/Reclose	A
Auto/Manual Lockout (Selectable)	S
None (Defaults to Auto Reset/Reclose)	X

- When Bell Alarm with Lockout is selected on the EntelliGuard G Circuit Breaker, then Code M must be selected.
- X is only valid on GE Legacy Circuit Breakers and Conversion Kits.
- M is valid on EntelliGuard G Breakers when a Bell Alarm is selected.
- A is valid on EntelliGuard G Breakers when a Bell Alarm is not selected.
- S is IEC Only

Digit 11 – Factory or Field Installed	
Manual Auto Trip Reset	Code
Factory Installed Trip Unit (Original)	F
Replacement Trip Unit (shipped loose)	R

EntelliGuard TU Trip Unit Rating Plugs (see page 20)

Sample	GTP	1600	U	16	40
Digit	1,2,3,4	5,6,7,8	9	10,11	12,13
	EntelliGuard Trip Unit Rating Plug	Universal Trip Unit Rating Plug (Rating in Amperes)	Universal Trip Plug	Smallest Sensor that accepts this plug (1600A)	Largest Sensor that accepts this plug (4000A)

EntelliGuard® G Power Circuit Breaker Section 6. Application Data

Introduction

The EntelliGuard G family of circuit breakers and related switching devices is a truly global line of protection and switching devices. It was designed from the ground up to provide reliable protection and operation in a wide range of power distribution systems. Combined with the EntelliGuard TU family of trip devices, EntelliGuard G circuit breakers provide superior protection and reliability with a maximum of flexibility and a minimum of compromise for your power protection and switching needs.

This section provides an overview of the circuit breaker's capability under UL 489 and UL 1066 standards.

Key Features

There are three product families:

UL1066 Low Voltage Power Circuit Breakers

- 800-5000A frames in three physical sizes.
- 400-5000A sensors with rating plugs as low as 150A and trip settings as low as 75A.
- Short circuit ratings as high as 150kA at 480V (tested at 508V).
- Withstand capability and selectivity as high as 100kA
- Continuously adjustable selective instantaneous as high as 30X the circuit breaker's rating.

UL489 Stored Energy Insulated Case Circuit Breakers

- 800-6000A frames in three physical sizes.
- 400-6000A sensors with rating plugs as low as 150A and trip settings as low as 75A.
- Short circuit ratings as high as 150kA at 480V.
- Withstand capability and selectivity as high as 100kA.
- Continuously adjustable selective instantaneous to 15X on all but the largest circuit breakers.
- Draw-out and stationary mounted, 100% rated in most sizes.

IEC Rated Circuit Breakers for IEC Equipment and Applications

- 800-6400A frames in three physical sizes.
- 400-6400A sensors adjustable to 20% of sensor size.
- Short circuit ratings as high as 150kA at 440V, 100kA at 690V, 80kA at 1000V.
- Rated breaking capacity 100%, $I_{cs} = I_{cu}$ for all frames.
- Withstand capability and selectivity as high as 100kA for 1sec.
- Continuously adjustable selective instantaneous as high as 30X the circuit breaker's rating.

All Types

- Stationary mounting capability with rear or front connections.
- Draw-out mounting with cassette and automatic shutter mechanism.
- Complete closed door operation capability – UL489, ANSI or IEC.
- Two-step stored energy mechanism for manual or electrically operated circuit breakers, suitable for fast throw-over or generator paralleling applications
- Remote racking device allowing maintenance personnel to rack circuit breakers in and out while standing outside the arc flash boundary.
- 3 and 4 pole configurations with the neutral on either side.
- Suitable for UL1008 transfer switch applications
- Alternate, settable and remote controllable instantaneous pickup with positive feedback.
- Industry's only fully controllable ZSI restrained and unrestrained settings.
- Industry's only fully selective instantaneous trip with selectivity enhancing ZSI capability.
- Field installable accessories with labels that may be seen through the circuit breaker's escutcheon.
- Easily accessible terminal contacts at the top or side of circuit breaker for use by installer – permanently labeled, color coded and interlocked with harnesses for fast, efficient, mistake-proof wiring.
- Advanced protection algorithms that allow maximum selectivity and protection at the same time with minimized need to sacrifice protection to get system reliability or visa versa.
- Trip curves and algorithms to optimally accommodate downstream fuses, older slower power circuit breakers, ultra fast current limiting devices or other EntelliGuard circuit breakers without sacrificing any more protection than absolutely necessary to achieve significant selectivity.

Ratings and Sizes

The EntelliGuard G family of overcurrent devices is available in 3 or 4 pole versions, in 3 physical sizes referred to as "envelopes" 1, 2 and 3. Four pole versions may have the neutral on the right- or left-most pole. The envelope and the number of poles are the main determinants for physical size and the space the device will require when installed in equipment or enclosures.

The circuit breakers and switches are further divided into "frame" sizes. The frame sizes follow the guidelines defined

under the applicable UL, IEC and ANSI standards as shown in the various ratings tables. Switchgear equipment is typically sized to match the frame ratings and physical size. Switchboards may be sized to match the installed circuit breaker's sensor rating.

Equipment cubicles or device mounting provisions are normally mechanically interlocked such that equivalent frames may be installed within a specific cubicle or space. When exchanging circuit breakers for maintenance purposes, care should be exercised so that there is no attempt to install a circuit breaker with a rating higher than what the equipment was designed to accommodate, even if the physical size seems similar.

Short Circuit Interrupting Ratings

The EntelliGuard G family of UL devices is available with short circuit ratings as high as 150kA at 480V, and withstand ratings as high as 100kA. UL1066 and ANSI C32 ratings are based on various tests performed at rated voltage plus 6%. Hence it is common to see low voltage circuit breakers listed as suitable for 254, 508 and 635V. Any UL 1066 listed device must be tested at these higher voltages if listed at the normal nominal voltage of 240, 480 and 600V. UL489 circuit breakers are tested at the nominal voltage. Both circuit breakers are subject to dielectric testing after interrupting faults to ensure the ability to sustain voltage.

Short circuit interrupting ratings are a measurement of the circuit breaker's ability to interrupt a particular value of fault current at a maximum power factor (also expressed as X/R ratio). For fault currents above 20,000A RMS, UL489 circuit breakers are tested at 20% power factor and UL1066 circuit breakers are tested at 15% power factor. When fault currents have power factors lower (higher X/R) than the test power factor, the circuit breaker's short circuit rating must be adjusted to compensate for the fault's lower PF. The adjustment is performed as shown in Figure 6.1. Table 6.2 shows various asymmetrical peak ratios for various power factors and X/R ratios. A power factor of 100% yields a symmetrical fault and hence the peak over RMS ratio is 1.41.

Figure 6.1. Short Circuit Rating Adjustment Equation

$$\frac{\text{CB's Test Peak}}{\text{Fault Peak}} = \text{Derate Ratio}$$

Table 6.1. First Half-Cycle Peak at Specific Fault X/R Ratios (excerpted from UL489)

Power Factor	X/R ratio	Maximum Peak at 1/2 Cycle
5%	20.0	2.63
6%	16.6	2.59
7%	14.3	2.55
8%	12.5	2.52
9%	11.7	2.50
9%	11.1	2.49
10%	10.0	2.46
11%	9.0	2.42
12%	8.3	2.39
13%	7.6	2.36
14%	7.1	2.34
15%	6.6	2.31
16%	6.2	2.28
17%	5.8	2.26
18%	5.5	2.23
19%	5.2	2.21
20%	4.9	2.18
100%	0.0	1.41

Consider a system where the fault current has an X/R ratio of 10 and the calculated RMS value is 92,000. A circuit breaker with a stated interrupting capability of 100,000 is being considered. Since the fault's X/R ratio is higher than the UL489 rating at 4.9, the circuit breaker's rating, 100kA, must be multiplied by 2.18/2.46 (from Table 6.1). The ratio is .89. Hence, the circuit breaker must be considered as if it is only rated for 89,000A. The UL489 100kA rated circuit breaker is not suitable for the application because its de-rated 89kA rating is below the available fault current of 92kA.

Consider an equivalent UL1066 circuit breaker tested at an X/R ratio of 6.6. The UL1066 circuit breaker must be de-rated by 2.31/2.46, which yields 0.94. The UL1066 circuit breaker is then de-rated to 0.94 times 100kA. The UL1066 circuit breaker is rated higher than the available fault current of 92kA and hence could be considered for the application.

Withstand Ratings, Selective Adjustable-, RELT- and Override-Instantaneous Protection (Darrin to provide additional sentence)

Instantaneous adjustment capability for any circuit breaker is intrinsically connected to the circuit breaker's withstand rating and the trip system's sensing methods. In the case of the EntelliGuard G family of circuit breakers, high withstand ratings allow for a broad range of instantaneous trip options. The trip system relies on high accuracy air core sensors not encumbered by the saturation concerns associated with iron core sensors

used in many other trip systems. This allows the EntelliGuard trip system to take full advantage of the circuit breaker's withstand rating, providing adjustable settings and full selectivity right up to the circuit breaker's high withstand level. EntelliGuard G circuit breakers, in conjunction with EntelliGuard TU trip units with GE's unique "selective instantaneous" algorithm, allow selectivity capability as high as 100kA with instantaneous on, and set at surprisingly low values. The EntelliGuard family of devices provides multiple solutions for your selectivity and protection problems.

Low Voltage Power Circuit Breakers (LVPCBs) listed to UL1066 have defined fault current withstand currents. EntelliGuard G UL489 Insulated Case Circuit Breakers also have substantial withstand ratings. The stated withstand current (Icw) allows the instantaneous protection of LVPCBs to be turned off or set at very high values, and it's what allows the short time bands of both types of circuit breakers to be delayed as much as 0.5sec. EntelliGuard G UL1066 LVPCBs with EntelliGuard TU trip units are available with two different instantaneous adjustment ranges to take full advantage of this capability.

The standard instantaneous adjustment range is 2-15X, adjustable in 1/2X increments on all UL 489 and UL1066 circuit breakers. EntelliGuard TU trips offer, for UL1066 LVPCBs only, an extended Instantaneous adjustment range that allows the instantaneous pickup to be continuously adjusted up to 30X, adjustable in 1X increments above 15X the rating plug. The maximum adjustable pickup setting is limited to approximately 95% of the circuit breaker's withstand rating, or 30X trip plug current rating, whichever is lower.

The EntelliGuard G's wide range of instantaneous adjustability allows for maximum flexibility in providing the settings that are required for selectivity or for optimum protection. Its capability is limited by its withstand rating and the instantaneous override. An instantaneous override is used in some circuit breakers to ensure that, if a fault exceeds the circuit breakers withstand capability, the circuit breaker trips quickly. In all UL489 EntelliGuard circuit breakers, the override protection is designed such that selectivity up to 100% of the stated circuit breaker's withstand rating is possible.

In UL1066 LVPCBs, maximum selective capability is achieved by using the adjustable instantaneous algorithm, even if it is set at maximum. When the adjustable instantaneous is enabled, regardless of setting, the override protection is set so that it will not trip for faults below the circuit breaker's withstand rating. If the adjustable instantaneous is disabled (turned off), then the override automatically adjusts

downward by approximately 9%. This lowers the maximum selective capability to 91% of the circuit breaker's withstand rating. The EntelliGuard G LVPCB may be selective up to the full withstand current with adjustable instantaneous on and 91% of withstand rating with adjustable instantaneous off.

The EntelliGuard TU trip unit also offers a second adjustable instantaneous trip called the Reduced Energy Let-Through (RELT) instantaneous pickup. This trip offers a faster algorithm suitable for application as alternate instantaneous pickup setting for temporary use when faster and more sensitive instantaneous protection is desired. The RELT setting is determined by the user and may be adjusted from 1.5X to 15X rating plug. Once set, the RELT function may be enabled or disabled locally at the trip unit or remotely via a 24Vac/dc signal, or serial communications.

When the trip unit receives a RELT enable command, it issues a feedback signal indicating the RELT setting is now active. The user may connect the RELT enable input to any 24Vac/dc source, such as a manual switch, automatic sensor, or both. The feedback signal may be connected to any desired signaling means with the proper ratings. For further details see Section 3 of this application guide.

Close and Latch Ratings and Making Current Release (MCR) Instantaneous Trip

EntelliGuard G circuit breakers have defined close and latch ratings as shown in Tables 6.2 through 6.4. The close and latch rating is a measurement of the circuit breaker's ability to close and latch closed on a fault. This value must be high enough to allow a circuit breaker to handle large transient inrush currents associated with certain types of loads, such as energy efficient motors or large capacitor banks.

Table 6.2. EntelliGuard G Circuit Breaker Close and Latch Ratings, UL489 Listed

Envelope	Amps	Type	Close and Latch Rating (kA)
1	800 - 2000	N, H	42
2	800 - 3000	N, H, M	65
3	4000 - 6000	M	85
		L	100

Table 6.3. EntelliGuard G Circuit Breaker Close and Latch Ratings, UL1066 Listed

Envelope	Amps	Type	Close and Latch Rating (kA)
1	800 - 2000	N, H	42
2	800 - 3000	N, E, M	65
3	4000 - 6000	M, B	85
		L	100

Table 6.4. EntelliGuard G Non-Automatic Switch Close, Latch, and Withstand Ratings, UL489 Listed

Envelope	Amps	Type	Close and Latch Rating (kA)
1	800 - 2000	N	42
2	800-3000	M	65
3	4000 - 6000	B	100

EntelliGuard G circuit breakers are provided with values that are high relative to the circuit breaker's load carrying capacity. The trip system provides a type of instantaneous protection called a Making Current Release (MCR) to provide more sensitive protection when closing. Should the trip system measure higher current than the MCR setting, it is very likely that the circuit breaker has been closed on a bolted fault, or low impedance, arcing fault. If that is the case, the MCR instantaneous will provide very fast protection, minimizing damage and hazard.

Operations

EntelliGuard G circuit breakers are designed to provide long life, even in operationally difficult environments. However, different standards have different ways of measuring and qualifying circuit breaker operations, hence slightly different numbers may apply to similar circuit breakers when defined within the context of different standards. Tables 6.5 and 6.6 describe the endurance parameters for the circuit breaker family.

Table 6.5. Operational Ratings, UL 489 Circuit Breakers

Envelope	Frame	Mechanical Operations	Electrical Operations at 508V	Electrical Operations at 635V
1	800-1600A	12500	10000	7500
	2000A	12500	7500	5000
2	800A	12500	5000	5000
	1600-3000A	5000	5000	5000
	3000-4000A	5000	3000	2000
3	5000A	5000	2000	1500
	6000A	5000	1500	1000

Table 6.6. Operational Ratings, UL1066/ANSI Circuit Breakers

Envelope	Frame	Mechanical Operations	Electrical Operations at 508V	Electrical Operations at 635V
1	800-1600A	12500	10000	7500
	2000A	12500	7500	5000
2	800A	12500	5000	5000
	1600-3200A	5000	5000	5000
3	3200- 4000A	5000	3000	2000
	5000A	5000	2000	1500

Per industry standards, operations are listed based on no maintenance during the testing. However, if some maintenance is done of some of the current carrying parts and arc chute, then over 20,000 electrical and mechanical operations are possible.

Selecting a Circuit Breaker for an Application

There are six application factors to consider in selecting current rating for a circuit breaker. These are:

1. Size of the cable or bus used in the line and load connections.
2. Actual installed ambient temperature.
3. System operating frequency.
4. Altitude of the installation.
5. Type of loading of the protected circuit.
6. Design safety factor.

The following simple relationship combines these six application factors into a single equation:

$$CR = IA \times A \times B \times C \times D \times E \times F$$

- CR Required circuit breaker current rating, amps
 IA Actual load current, amps
 A Cable or bus sizing factor
 B Ambient temperature rating factor
 C Frequency rating factor
 D Altitude rating factor
 E Load class rating factor
 F Safety factor

Cable or Bus Size – Factor A

The thermal design of a circuit breaker takes into account the ability of the line and load cables or buses to act as heat sinks. For UL489 Listed circuit breakers, UL has assigned specific cable or bus sizes for each current rating. Generally, these assignments are coordinated with specific conductor temperature ratings. When using a conductor with an increased temperature rating, the higher rating decreases both the cross-sectional area and its ability to conduct heat from the circuit breaker. If an

EntelliGuard G circuit breaker is used with cables directly connected, contact your GE application engineer for information to ensure proper cabling information. Cable with insulation ratings above 75°C may be used, providing it is sized to 75°C ampacity per the NEC or other applicable codes.

Ambient Temperature – Factor B

Ambient temperatures have a wide effect on the rating of the breaker-cable system. While the internal sensing and tripping circuitry in EntelliGuard TU trip units are ambient insensitive, high-ambient temperatures may cause internal components to exceed operating temperature limits. Low temperatures substantially increase the current-carrying capabilities of the breaker-cable system until other limiting factors occur (e.g., lubrication problems or mechanical binding of internal parts due to differential contraction). The ambient temperature around an EntelliGuard G breaker should not be less than -20°C nor exceed 70°C.

Ambient temperature always refers to the temperature of the air immediately surrounding the breaker and not the temperature of the air outside the breaker's enclosure. Room or outside air temperatures only establish the thermal floor to which all other heating is added. To convert breaker ambient from room ambient, it is necessary to know the temperature rise within the equipment housing the breaker. Temperature rise is a function of several variables, including heating caused by other equipment, ventilation, solar heating, factors relating to group mounting and the free surface area of the breaker's enclosure. Once the device's ambient temperature is determined, select Factor B from Table 6.7.

Table 6.7. Ambient Temperature Rating – Factor B

Ambient Temperature, °C ¹	Maximum Wire Insulating Rating °C ²	Factor B
25	75	1
40	90	1
50	105	1
60	125	1.1
70	125	1.15

1 Average air temperature over a 24-hour period outside the breaker's insulated case, but inside the enclosure.

2 Cable (wire) must be based on 75°C current rating per Table 3 10-16, current National Electrical Code.

Operating Frequency – Factor C

All UL EntelliGuard circuit breakers may be applied at their published ratings on 50Hz and 60Hz power systems. At nominal system frequencies less than 50Hz but above direct current, digital solid-state trip may become inaccurate. On direct current systems, digital solid-state

trip units are completely inoperative. EntelliGuard G circuit breakers may be used on DC applications, but EntelliGuard TU trip units may not.

System operating frequencies above 60Hz may change the performance and ratings of circuit breakers by heating metallic parts and significantly reducing interrupting capacity. EntelliGuard TU trip units are not suitable for applications at 400Hz.

For operating frequencies of both 50Hz and 60Hz, the operating frequency rating Factor C = 1.00. For operating frequencies other than 50Hz and 60Hz, contact your GE applications engineer.

Altitude – Factor “D”

EntelliGuard G UL circuit breakers are designed for operation at altitudes from sea level to 6000ft (1800m). Reduced air densities at altitudes above 6000ft affect the ability of the circuit breaker to both transfer heat and interrupt short circuits. Determine the altitude of the breaker's installation, and select the altitude rating - factor D from Table 6.8.

Table 6.8. Altitude Rating – Factor D

Altitude		Factor D
Feet	Meters	
100 - 6,000	30 - 1,800	1
6,001 - 10,000	1,801 - 3,000	1.04
>10,001	>3,001	1.08

Load Class Rating – Factor E

The type of load and its duty cycle must be considered in the application of EntelliGuard G circuit breakers. Loads such as capacitors and electromagnets require a substantial and continuous de-rating factor if the breaker is normally used to switch the load. With loads such as resistance welders, the breaker's continuous current rating must be no less than 125% of the welder's 100% duty-cycle rating.

In general, circuit breakers are intended for the protection of insulated cable. Where a circuit breaker is intended to protect load equipment, prudent engineering practices call for obtaining factory review and concurrence with the selection of a specific protective device. Load class selection Factor E for typical applications are listed in Table 6.9.

Table 6.9. Load Class Rating – Factor E

Load Type	Factor E
Switching Electromagnets	1.5
Single Motor Branch Circuit Protection (Normal Duty)*	1.5
Switching Capacitors	1.5
Single Motor Branch Circuit Protection (Heavy Duty)*	1.75
All Other load Types (Normal Duty)	1

*Use this factor to either plugging duty or starting more than 25 times per hour, where the rms current cannot be easily calculated.

Safety – Factor F

A safety factor is used to provide a design margin between the rating of a circuit breaker and the derived operating current using all of the applicable selection factors. A safety factor of at least 10% is often used to ensure the circuit breaker is adequately sized. In addition it may be useful to consider future growth.

Other Factors that Influence Circuit Breaker Sizing 100% vs. 80% Ratings

All EntelliGuard G circuit breakers are 100% rated except for the 6000A stationary mounted UL 489 circuit breaker. Circuit breakers that are 100% rated are not required to be sized at 125% of the expected load. However, it is recommended that a safety factor, as described above, always be considered when selecting overcurrent device sizes.

An important consideration may be the circuit breaker's desired selective and protection performance within the context of the system where it is installed. Certain settings are functions of the trip plugs, others of the sensors. In Table 3.14 you will find the sensors available on a per frame basis. Table 3.12 identifies the trip rating plugs available for each sensor. Table 6.10 identifies the relationship between specific circuit breakers and trip parameters.

Table 6.10. Circuit Breaker and Trip Parameters

Adjustment or Capability	Abbreviation	Trip Designation	Setting or Range
Trip Current Rating Plug	In	In	~37.5-100% of sensor
Long Time Pickup	LTPU	LTPU	Plug x pickup setting
Short Time Pickup	STPU	STPU	1.5X - 12X of the LTPU
Instantaneous Pickup	IPU	I	2X -15 or 30X of the trip current rating plug
Maximum Achievable Selectivity	= I _{cw}	N/A	Function of the withstand rating
Ground Fault Pickup	GF	GF	20-60% sensor, <1200A
Override Pickup	HSIOC	N/A	Function of the withstand rating
Making Current Release	MCR	N/A	Function of the close and latch rating

EntelliGuard® G Power Circuit Breaker
Section 7. Physical Data

Dimensions and Weights

To download detailed dimensional drawings like those shown in Figure 7.1, visit www.geelectrical.com.

Figure 7.1. Sample Dimensional Drawing

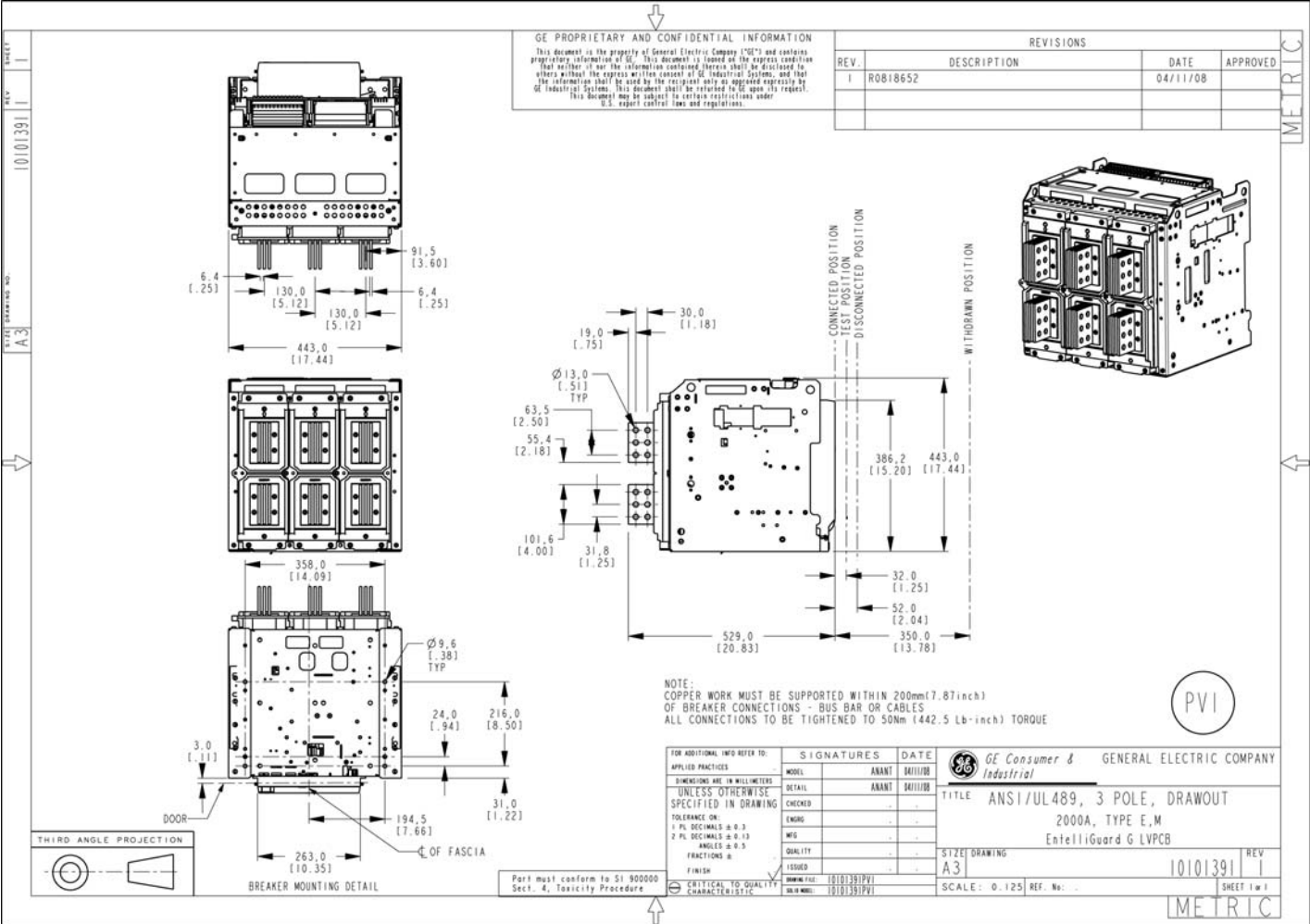


Table 7.1 provides an index of drawings.

Table 7.1. Drawing Index

Description	Mounting Location of Secondary Disconnect	Assembly #
400 - 1600A, Type N & H, 3-pole, draw-out, ANSI/UL	Side	10101387
400 - 1600A, Type E & M, 3-pole, draw-out, ANSI/UL	Top	10101422
2000A, Type N & H, 3-pole, draw-out, ANSI/UL	Side	10101388
2000A, Type E & M, 3-pole, draw-out, ANSI/UL	Top	10101391
2500 - 3200A, Type N, E & M, 3-pole, draw-out, ANSI	Top	10101393
2500 - 3000A, Type N, H & M, 3-pole, draw-out, UL	Top	10101392
3000 - 6000A, Type B, M & L, 3-pole, draw-out, ANSI/UL	Top	10101397
400 - 1600A, Type N & H, 3-pole, fixed, ANSI/UL	Top	10101389
400 - 2000A, Type E & M, 3-pole, fixed, ANSI/UL	Top	10101394
2000A, Type N & H, 3-pole, fixed, ANSI/UL	Top	10101390
2500 - 3200A, Type N, E & M, 3-pole, fixed, ANSI	Top	10101396
2500 - 3000A, Type N, H & M, 3-pole, fixed, UL	Top	10101395
3000 - 4000A, Type B, M & L, 3-pole, fixed, ANSI/UL	Top	10101399
5000 - 6000A, Type M, B & L, 3-pole, fixed, ANSI/UL	Top	10101398
400 - 2000A, Type N & H, 3-pole, front access, UL	Top	10101452
3000A, Type E & M, 3-pole, front access, UL	Top	10101453
6000A, Type B & L, 3-pole, front access, UL	Top	10101454
400 - 1600A, Type N & H, 4-pole, draw-out, ANSI/UL	Side	10101456
400 - 1600A, Type E & M, 4-pole, draw-out, ANSI/UL	Top	10101471
2000A, Type N & H, 4-pole, draw-out, ANSI/UL	Side	10101457
2000A, Type E & M, 4-pole, draw-out, ANSI/UL	Top	10101462
2500 - 3200A, Type N, E & M, 4-pole, draw-out, ANSI	Top	10101464
2500 - 3000A, Type N, H & M, 4-pole, draw-out, UL	Top	10101463
3000 - 6000A, Type B, M & L, 4-pole, draw-out, ANSI/UL	Top	10101458
400 - 1600A, Type N & H, 4-pole, fixed, ANSI/UL	Top	10101460
400 - 2000A, Type E & M, 4-pole, fixed, ANSI/UL	Top	10101465
2000A, Type N & H, 4-pole, fixed, ANSI/UL	Top	10101461
2500 - 3200A, Type N, E & M, 4-pole, fixed, ANSI	Top	10101467
2500 - 3000A, Type N, H & M, 4-pole, fixed, UL	Top	10101466
3000 - 4000A, Type B, M & L, 4-pole, fixed, ANSI/UL	Top	10101468
5000 - 6000A, Type M, B & L, 4-pole, fixed, ANSI/UL	Top	10101469
400 - 2000A, Type N & H, 4-pole, front access, UL	Top	10101474
3000A, Type E & M, 4-pole, front access, UL	Top	10101475
6000A, Type B & L, 4-pole, front access, UL	Top	10101476
Door Cutout Detail for a Fixed Breaker	n/a	10101498
Door Cutout Detail for a Drawout Breaker	n/a	10101499
400 - 1600A, Type N & H, 3-pole, draw-out, ANSI/UL, Top Mounted Secondary Disconnects	Top	10101848
2000A, Type N & H, 3-pole, draw-out, ANSI/UL, Top Mounted Secondary Disconnects	Top	10101849
400 - 1600A, Type N & H, 4-pole, draw-out, ANSI/UL, Top Mounted Secondary Disconnects	Top	10101850
2000A, Type N & H, 4-pole, draw-out, ANSI/UL, Top Mounted Secondary Disconnects	Top	10101851

Dimensions & Weights

Table 7.2. 3-pole, UL/ANSI

Type	Design	Width		Depth		Height		Weight	
		in.	mm	in.	mm	in.	mm	lbs.	kg
Envelope 1, Top Mounted, UL/ANSI	Fixed breaker – back connected	13.50	343	17.17	436	17.40	442	136.7	62
	Drawout breaker - Moving portion	13.07	332	16.34	415	17.24	438	149.9	68
	Cassette/substructure	13.50	343	20.83	529	17.44	443	110.2	50
Envelope 1, Side Mounted, UL/ANSI	Fixed breaker – back connected	16.14	410	17.17	436	15.98	406	136.7	62
	Drawout breaker - Moving portion	15.35	390	16.34	415	15.83	402	149.9	68
	Cassette/substructure	15.83	402	20.83	529	15.98	406	110.2	50
Envelope 2, Up to 2000A, UL/ANSI	Fixed breaker – back connected	17.17	436	17.17	436	17.40	442	165.3	75
	Drawout breaker - Moving portion	17.01	432	16.34	415	17.24	438	176.4	80
	Cassette/substructure	17.44	443	20.83	529	17.44	443	114.6	52
Envelope 2, Up to 3000A, UL	Fixed breaker – back connected	17.17	436	22.17	563	17.40	442	253.5	115
	Drawout breaker - Moving portion	17.01	432	16.34	415	17.24	438	209.4	95
	Cassette/substructure	17.44	443	26.14	664	17.44	443	231.5	105
Envelope 2, Up to 3200A, ANSI	Fixed breaker – back connected	17.17	436	22.17	563	17.40	442	275.6	125
	Drawout breaker - Moving portion	17.01	432	16.34	415	17.24	438	209.4	95
	Cassette/substructure	17.44	443	26.14	664	17.44	443	246.9	112
Envelope 3, Up to 4000A, ANSI/UL	Fixed breaker – back connected	28.98	736	17.17	436	17.40	442	286.6	130
Envelope 3, Up to 5000A ANSI / 6000A UL	Fixed breaker – back connected	28.98	736	22.17	563	17.40	442	463.0	210
Envelope 3, All Ratings	Drawout breaker - Moving portion	28.82	732	16.34	415	17.24	438	330.7	150
	Cassette/substructure	29.25	743	26.14	664	17.44	443	396.8	180

Table 7.3. 4-pole, UL/ANSI

Type	Design	Width		Depth		Height		Weight	
		in.	mm	in.	mm	in.	mm	lbs.	kg
Envelope 1, Top Mounted, UL/ANSI	Fixed breaker – back connected	17.44	443	17.17	436	17.40	442	180.8	82
	Drawout breaker - Moving portion	17.01	432	16.34	415	17.24	438	198.4	90
	Cassette/substructure	17.44	443	20.83	529	17.44	443	143.3	65
Envelope 1, Side Mounted, UL/ANSI	Fixed breaker – back connected	20.08	510	17.17	436	15.98	406	180.8	82
	Drawout breaker - Moving portion	19.29	490	16.34	415	15.83	402	198.4	90
	Cassette/substructure	19.76	502	20.83	529	15.98	406	143.3	65
Envelope 2, Up to 2000A, UL/ANSI	Fixed breaker – back connected	22.28	566	17.17	436	17.40	442	220.5	100
	Drawout breaker - Moving portion	22.13	562	16.34	415	17.24	438	242.5	110
	Cassette/substructure	22.56	573	20.83	529	17.44	443	154.3	70
Envelope 2, Up to 3000A, UL	Fixed breaker – back connected	22.28	566	22.17	563	17.40	442	330.7	150
	Drawout breaker - Moving portion	22.13	562	16.34	415	17.24	438	275.6	125
	Cassette/substructure	22.56	573	26.14	664	17.44	443	308.6	140
Envelope 2, Up to 3200A, ANSI	Fixed breaker – back connected	22.28	566	22.17	563	17.40	442	363.8	165
	Drawout breaker - Moving portion	22.13	562	16.34	415	17.24	438	275.6	125
	Cassette/substructure	22.56	573	26.14	664	17.44	443	330.7	150
Envelope 3, Up to 4000A, ANSI/UL	Fixed breaker – back connected	38.03	966	22.17	563	17.40	442	385.8	175
Envelope 3, Up to 5000A ANSI / 6000A UL	Fixed breaker – back connected	38.03	966	22.17	563	17.40	442	617.3	280
Envelope 3, All Ratings	Drawout breaker - Moving portion	37.87	962	16.34	415	17.24	438	440.9	200
	Cassette/substructure	38.31	973	26.14	664	17.44	443	529.1	240

EntelliGuard® G Power Circuit Breaker

Section 8. Standards and References

Underwriters Laboratories® (UL)

UL 489 and UL 489-SB2 - Standard for Molded Case Circuit Breakers and Circuit Breaker Enclosures
UL 1066 - Standard for Safety Low-Voltage AC and DC Power Circuit Breakers Used in Enclosures

Order from:
UL Publication Stock
333 Pfingsten Road
Northbrook, IL 60062 USA

National Electrical Manufacturers Association (NEMA)

AB-1/2002 Standards Publication - Molded Case Circuit Breakers and Molded Case Switches
SG3/1995 - Standards and Ratings for the Application of Low-Voltage Power Circuit Breakers
SG5/1995 - Power Switchgear Assemblies

Order from:
NEMA Publication
155 East 44th Street
New York, NY 10017 USA

Canadian Standards Association (CSA)

CSA 22.2 NO 5.1 - Standards for Branch Circuit Protection

Order from:
Canadian Standards Association
178 Rexdale Blvd.
Rexdale, Ontario, Canada M9WR3

Institute of Electrical and Electronics Engineers (IEEE)

IEEE 693 - Recommended Practices for Seismic Design of Substations

Order from:
IEEE
345 East 47th Street,
New York, NY 10017 USA

American National Standard Institute (ANSI)

ANSI C37.13/1990 - Low-Voltage AC Power Circuit Breaker Used in Enclosures (600-Volt Insulation Class)
ANSI C37.16/2000 - Recommendations for Low Voltage Power Circuit Breakers and AC Power Circuit Protectors, Preferred Ratings, Related Requirements, and Application
ANSI C37.17/1990 - American National Standard for Trip Devices for AC and General Purpose DC Low Voltage Power Circuit Breakers
ANSI C37.20.1/2000 - Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear
ANSI C37.50/1989 (R1995) - Test Procedures for Low-Voltage AC Power Circuit Breakers Used in Enclosures
ANSI/IEEE C37.90.1/1993 - IEEE Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems
ANSI/IEEE C37.90.2/1993 - Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceiver

Order from:
ANSI
11 West 42nd Street,
New York, NY 10036 USA

International Electrotechnical Committee (IEC)

IEC 60947-1 (Ed. 4/2004) - Electrical Equipment for Low Voltage, High Power Switching Equipment (Also applies to Electromagnetic Compatibility)

IEC 60947-2 (Ed. 4/2006) - Electrical Equipment for Low Voltage, High Power Switching Equipment (Also applies to Electromagnetic Compatibility)

IEC 60947-3 (Ed. 4, Am 1, Am 2/2002) - Electrical equipment for Low voltage, high power switching equipment (Also applies to Electromagnetic Compatibility)
IEC 68-2-1 (Am 1/1993) - Environmental Testing Standards/Dry Cold at -55°C Operational Temperature
IEC 68-2-2 (Am 1/1993) - Environmental Testing Standards/Dry Heat at +85°C Operational Temperature
IEC 68-2-30 - (Am 1/1985) - Environmental Testing Standards/Operational Temperature and Humidity (temp. +55°C, rel. humidity 95%)
IEC 68-2-52 Level 2 - (Am 1/1996) - Environmental Testing Standards/Salt Mist-Corrosion
IEC 801-2 2nd Edition 1991-04 - Electromagnetic Compatibility for Industrial-Process, Measurement and Control Equipments
Part 2: Electrostatic Discharge Requirements

Order from:
Bureau Central de la Commission
Electrotechnique Internationale
3 rue de Varamb'e
Geneve, SUISSE

National Electrical Code®

Order from:
National Fire Protection Association
Batterymarch Park
Quincy, MA 02269 USA

American Society for Testing and Materials (ASTM)

ASTM B117-73 (Reapproved 1979)
Standard Method of Salt Spray (Fog) Testing

Order from:
ASTM
1916 Race Street
Philadelphia, PA 19103 USA

Military Standard (MIL-STD)

MIL-STD-810E - Environmental Test Methods and Engineering Guidelines

Order from:
Defense Printing Service
700 Robbins Avenue, Bldg. 4D
Philadelphia, PA 19111-5094 USA

Seismic Qualifications to All Major Building Code Standards

IBC - International Building Code
UBC - Uniform Building Code
BOCA - Building Officials and Code Administrators
CBC - California Building Code
SBC - Standard Building Code

Other

IEC Environmental: 68-2-1,-2,-3,-6,-11,-14,-14,-27,-29,-30,-31
IEC Environmental: 721
Lloyds Register of Shipping, Germanischer Lloyds, ABS (American Bureau of Shipping)
European ROHS Directives
GE Consumer & Industrial Engineering Test Procedures (ETPs) and Standing Instructions (S.I.s) Standing Instructions (S.I.s): S.I. 900001S001 - Program Technical Review Discipline

American Society for Testing and Materials (ASTM)

ASTM B117-73 (Reapproved 1979)
Standard Method of Salt Spray (Fog) Testing

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CBC – California Building Code

SBC – Standard Building Code

Other

IEC Environmental: 68-2-1,-2,-3,-6,-11,-14,-14,-27,-29,-30,-31

IEC Environmental: 721

Lloyds Register of Shipping, Germanischer Lloyds, ABS (American Bureau of Shipping)

European ROHS Directives

GE Consumer & Industrial Engineering Test Procedures

(ETPs) and Standing Instructions (S.I.s) Standing

Instructions (S.I.s): S.I. 900001S001 - Program Technical

Review Discipline

EntelliGuard® G Publications

To download publications like those shown below, visit www.geelectrical.com.

Publications	Pub #
EntelliGuard® G IOM	DEH-41304
Time Current Curves: EntelliGuard® TU Trip Unit for EntelliGuard® G; Ground Fault	DES-093
Time Current Curves: EntelliGuard® TU Trip Unit for EntelliGuard® G; Instantaneous, Override (HSIOC), Reduced Energy Let-Through Instantaneous (RELT)	DES-094
Time Current Curves: EntelliGuard® TU Trip Unit for EntelliGuard® G; Long-Time Circuit Breaker Characteristics	DES-090
Time Current Curves: EntelliGuard® TU Trip Unit for EntelliGuard® G; Long-Time Fuse-Like Characteristics	DES-091
Time Current Curves: EntelliGuard® TU Trip Unit for EntelliGuard® G; Short-Time Pickup and Delay Bands	DES-092
Secondary Disconnects - Drawout	DEH-41401
CT Mounting for External Ground Fault	DEH-41402
Position Switch Kit	DEH-41403
Back Connected Terminations	DEH-41404
Front Connected Terminations	DEH-41405
Time Delay Module	DEH-41406
Key Interlock Kit - Breaker Mounted	DEH-41407
Door Interlock Kit	DEH-41408
Bell Alarm w/ Lockout	DEH-41409
Undervoltage Device	DEH-41410
Shunt Trip	DEH-41411
Remote Close Accessory Close Coil	DEH-41412
Motor Operator	DEH-41413
Pushbutton Padlock Device	DEH-41414
Aux Switch	DEH-41415
Operations Counter	DEH-41416
Secondary Disconnects - Fixed	DEH-41417
Command Close Coil	DEH-41418
Ready To Close (RTC)	DEH-41419
Coil Signaling Contacts	DEH-41420
Mechanical Interlocks (fixed and drawout)	
Key Interlock Cassette Mounted	
IP54 Door	
Finger Assembly using Cat #GUNI	
Rejection Scheme	

NOTES:

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NOTES:

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41 Woodford Avenue
Plainville, CT 06062

www.geelectrical.com/revolution



imagination at work

Record Plus Molded Case Circuit Breakers



imagination at work

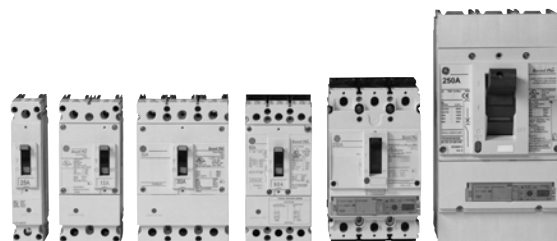
Record Plus At a Glance

Molded Case Circuit Breaker

Characteristics																									
			FC 100 100A					FB 100 100A							FE 250 250A			FG 600 600A							
(Max) Frame Rating			100A					100A							250A			600A							
Trip Unit			Thermal-Magnetic					Thermal - Magnetic							Electronic			Electronic							
Current Range			15A - 100A					15A - 100A							20A - 250A			100A - 600A							
Frame			FCS	FCV	FCN	FCH	FCL	FBV	FBN		FBH		FBL		FEN	FEH	FEL	FGN	FGH	FGL	FGP				
Poles			2, 3					1	2	3	1	2	3	1	2	3	2, 3		2, 3						
Interruption Ratings	UL / CSA Rating (kA RMS) (50 / 60 Hz AC)	240 V	42	65	150	200	200	35	65	65	150	100	200	100	200	150	200	200	150	200	200	200			
		277V	-	-	-	-	-	35	-	65	-	100	-	150	-	-	-	-	-	-	-	-			
		480 V	25	35	65	100	150	-	35	-	65	-	100	-	150	65	100	150	65	100	150	200			
		347V	-	-	-	-	-	22	-	25	-	35	-	42	-	-	-	-	-	-	-	-			
		600/347 V	18	22	25	35	42	-	22	-	25	-	35	-	42	-	-	-	-	-	-	-			
	UL / CSA Rating (kA @ VDC)	600 V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25	35	42	65			
		250V (2p)	22	25	30	42	65	-		-		-		-		-		-							
		500V (3p)	30	35	42	65	80	-		-		-		-		-		-							
	IEC 947-2 Rating (50/60 Hz AC)	220-240 V	36	50	85	100	200	-							-							85	100	200	-
		400 - 415 V	22	30	50	80	150															50	80	150	-
		500V	14	18	22	36	50															-	-	-	-
		690 V	-	-	-	-	-															10	22	40	-
IEC 947-2 (kA @ VDC)	250 (2p)	22	25	30	42	65	-		-		-		-		-		-								
	500 (3p)	30	35	42	65	80	-		-		-		-		-		-								
Additional Markings / Ratings	cUL		Yes					Yes		Yes		Yes		Yes		Yes		Yes							
	HACR		Yes					Yes		Yes		Yes		Yes		Yes		Yes							
	Reverse Feed		Yes					Yes		Yes		Yes		Yes		Yes		Yes	No						
	Naval		Yes					Yes		Yes		Yes		Yes		Yes		No							
	HID		Yes (15-50A)					Yes (15-50A)		Yes (15-50A)		Yes (15-50A)		No		No		No							
Current Limiting			Yes					Yes		Yes		Yes		Yes		Yes		Yes							
GE Equipment Availability	A-Series (Main)		-					-							-			AD, AE, AQ							
	A-Series (Branch)		-					AD							-			-							
	Spectra (Main)		-					-							-			SBO / SPO							
	Spectra (Branch)		SBO / SPO					SBO / SPO							SBO / SPO			SBO / SPO							
Envelope	Dimensions	H (in / mm)	6.4 / 162.6					6.45 / 163.8							6.70 / 170.1			10.31 / 262.0							
		W (in / mm)	3.0 / 76.2					1-Pole		2- Pole		3- Pole			4.11 / 104.4			5.46 / 138.7							
								1.36 / 34.5		2.74 / 69.6		4.11 / 104.4													
	Weight	(lb)	3.2 / 81.3					3.28 / 83.3		3.28 / 83.3		3.28 / 83.3			3.52 / 89.5			4.53 / 115.0							
								2.5		1.1		2.6		3.3			4.5			22					

Molded Case Switch

Characteristics			FC 100	
(Max) Frame Rating			100A	
Trip Unit			Molded Case Switch	
Current Range			60 or 100A	
Poles			2, 3	
Withstand Rating (kA RMS @VAC)	240 V	200		
	480 V	150		
	600 V	42		
Envelope	Dimensions	H (in / mm)	6.4 / 162.6	
		W (in / mm)	3.0 / 76.2	
		D (in / mm)	3.2 / 81.3	
	Weight	(lb)	2.5	



*Molded Case Switch Withstand ratings depend upon the short circuit rating of an upstream fuse or circuit breaker. The maximum withstand rating is limited to the rating of the upstream device or the value in this table, whichever is less. The upstream device must have an instantaneous trip function or element and its rated amperage may not exceed the rated current of the switch

Series Ratings: DET-008
Selectivity Ratings: DET-537

Product Markings

FB100

- cUL US – UL 489 File E-11592
- HACR, Naval, Current Limiting
- HID (15-50A)
- FB Breakers are NOT marked Line/Load and are suitable for Reverse Feed

FC100

- cUL US – UL 489 File E-11592
- IEC 947-2 and Associated EN Sections
- HACR, Naval, Current Limiting
- FC Breakers are NOT marked Line/Load and are suitable for Reverse Feed

FE250

- cUL US – UL 489 File E-11592
- HACR, Naval, Current Limiting
- FE Breakers are NOT marked Line/Load and are suitable for Reverse Feed

FG600

- cUL US – UL 489 File E-11592
- IEC 947-2 and Associated EN Sections
- HACR, Current Limiting
- FGN and FGH breakers are NOT marked Line/Load and are suitable for Reverse Feed
- FGL and FGP breakers are marked Line/Load and are NOT suitable for Reverse Feed

Features and Benefits

GE's name is synonymous with a broad range of products designed to meet our customers' changing and competitive environment. Our drive to exceed our customers' expectations is the foundation for continual renewal of our commitment to provide innovative low voltage solutions.

Using world class design and development tools like Six Sigma, Computer Simulations and Lean Manufacturing, Record Plus is intended to meet and exceed the most stringent quality, safety and performance standards. At GE, we are proud to offer a product that will offer years of reliable and dependable protection.

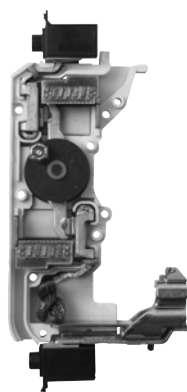
Record Plus is a line of high performance protective devices that are designed to be aesthetically and technically compatible and suited for a wide range of applications. The high short circuit ratings and selective coordination capabilities of Record Plus provide a common platform solution to a wide range of commercial and industrial applications.

Advanced and Powerful

Double rotary style contacts and features such as reverse loop current paths and advanced arcing chamber designs give Record Plus breakers exceptional current limiting performance. Advanced thermal-magnetic and electronic trip units allow Record Plus circuit breakers to respond to faults at the most downstream level, isolating outages to circuits affected by a fault. These two features can provide a combination of arc flash reduction and selectivity, thereby meeting the demands of today's complex distribution systems. Specify Record Plus breakers where total selective coordination is required.

In addition to current limitation, the Record Plus double rotary contact structure makes these breakers capable of exceptionally high short circuit ratings. Frames 250A and below are capable of 150kAIC, while the 600A frame

is rated up to 200kA. Specify and use Record Plus in spot networks, downtown distribution grids or anywhere available currents are high.



Flexible and Versatile

Record Plus uses a unique combination of thermal-magnetic and electronic trip units to provide appropriate protections depending on frame size. Smaller frames use non-adjustable thermal-magnetic trip units to provide more cost effective solutions for protecting smaller branch loads. The larger frames use a combination of electronic trip units that give users the flexibility of setting breaker amp rating with ratings plugs, and in the case of the 600A frame, adjustability to tailor the protections to the specifics of individual distribution networks.

Record Plus internal accessories are common for the entire family. Shunt trips, undervoltage releases, and auxiliary and bell alarm contacts are available in varying configurations, with operating voltages to meet a wide array of application needs. The accessories are UL listed for field installation, installable without exposure to current carrying components. The flexibility and ease of installation of these accessories allows breakers to be customized in minutes. A contractor or end user can field accessorize any Record Plus breaker in a few minutes using common hand tools. OEMs can, by keeping only a few accessory part numbers in stock, customize Record Plus breakers on-the-fly to meet customer requirements.

Trip Units and Protections

Record Plus 100A FC and FB are fitted with factory installed non-adjustable thermal-magnetic trip units that offer the most cost effective solution for protecting a large number of smaller ampacity branch circuits.

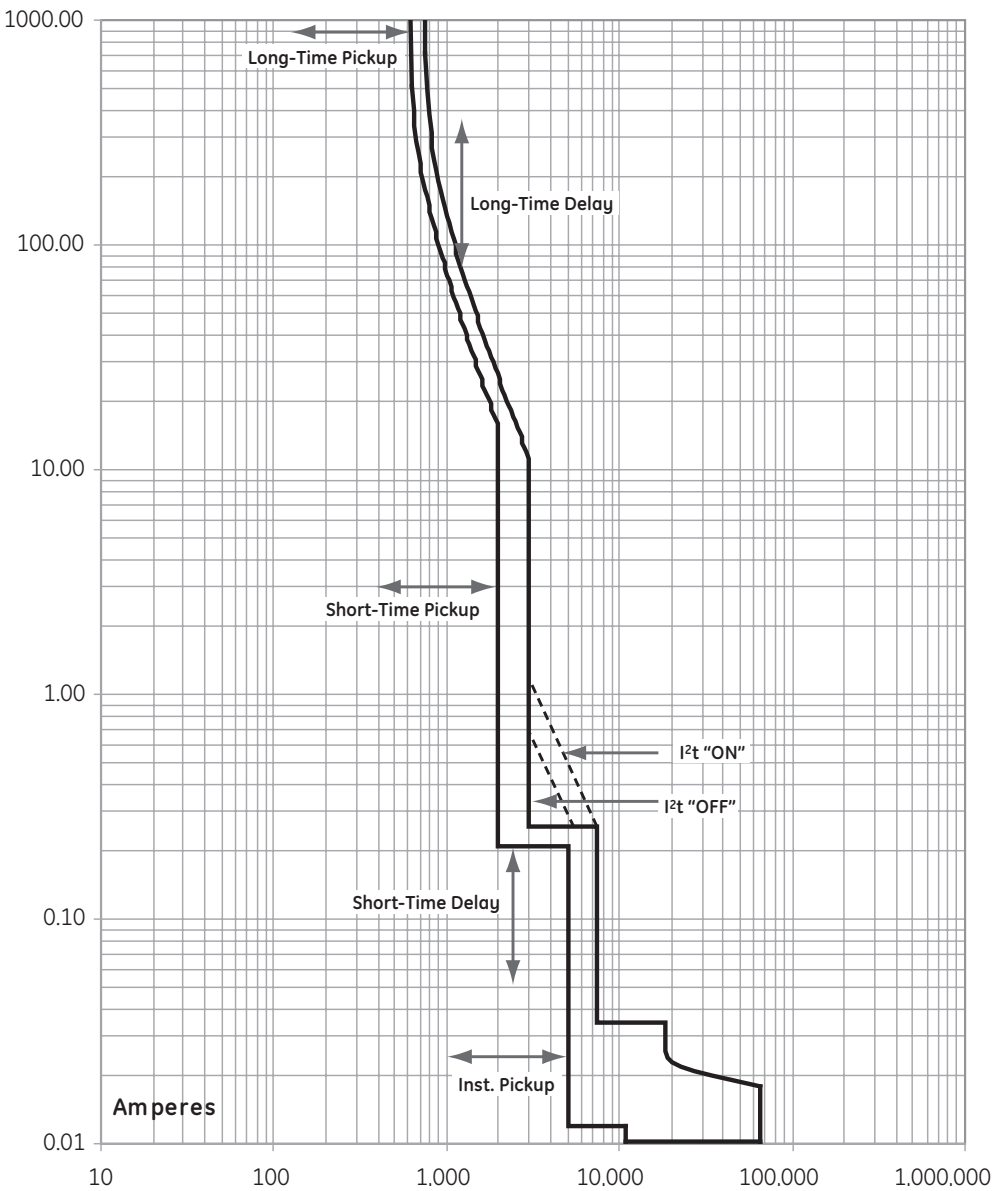
The Record Plus 250A (FE) and 600A (FG) frames utilize electronic SMR1 trip units, which use ratings plugs to set breaker ampacity. Ratings plugs are uniquely keyed so that they may only be used in the appropriate breaker frame. The rating plugs allow the maximum amp rating of the breaker to be changed in the field in a few minutes, but offers more control than an adjustment knob or dial. The electronic trip unit also provides the user with an easily accessible adjustment of the instantaneous pickup level.

Frame	Amp Range	Poles	Trip Unit Type	Maximum Amps (CT Rating)	Amp Rating / Rating Plug
FB	15-100A	1, 2, 3	Thermal-Magnetic	N/A	15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100
FC	15-100A	2, 3	Thermal-Magnetic	N/A	15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100
FE	20-250A	2, 3	SMR1 Electronic	25	20, 25
				60	25, 30, 40, 50, 60
				125	50, 60, 70, 80, 90, 100, 110, 125
				150	70, 80, 90, 100, 110, 125, 150
				250	100, 110, 125, 150, 175, 225, 250
FG	100-600A	2, 3	SMR1 or SMR2 Electronic	250	100, 110, 125, 150, 175, 200, 225, 250
				400	175, 200, 225, 250, 300, 350, 400
				600	300, 350, 400, 450, 500, 600

The 600A (FG) is optionally available with the SMR2 electronic trip unit. The SMR2 trip unit is a full featured trip unit that, like the SMR1, utilizes user installed rating plugs to determine the circuit breaker rating. SMR2 trip rating plugs are available in fixed or adjustable versions. The fixed version provides LT pickup equal to the value of the rating plug. The adjustable version allows the user to adjust the Long-Time (LT) pickup as a percentage of the rating plug's maximum rating, up to a maximum equal to the rating of the plug.

The SMR2 trip unit features adjustable short-time (ST) pickup and delay, and adjustable instantaneous (INST) pickup. Zone Selective Interlocking (ZSI) capability is available as well. User installed expansion modules make available Adjustable Ground Fault (GF) Trip or Ground Fault Alarm, Communications, Load Shedding, Basic Metering, and Trip Mode Indication.

Frame	Trip Unit Type	LT	ST	Inst	GF
FE 250	SMR1 Electronic	Set by Rating Plug	N/A	Adjustable	N/A
FG 600	SMR1 Electronic	Set by Rating Plug	N/A	Adjustable	N/A
	SMR2 Electronic	Set by Rating Plug	Fixed	Fixed	Adjustable
		Adjustable - Max. Set by Rating Plug	Adjustable PU and Delay	Adjustable	Adjustable PU and Delay



Long-time Protection

Long time protection is fixed for SMR1 equipped FE250 and FG600 breakers; the long-time pickup value will be the ampacity of the rating plug selected. SMR2 equipped FG600 breakers can be fitted with either of two types of rating plugs. A fixed rating plug will provide a long-time pickup value equal to that of the rating plug. An adjustable rating plug will enable the long-time pickup and delay to be user adjusted.

Long-time Pickup

For each SMR2 adjustable rating plug, there are sixteen possible rating plug positions, labeled in Amps, up to a maximum setting equal to the rating of the plug. This setting establishes the current setting of the breaker, which is the maximum current the breaker will carry continuously without tripping.

Long-time Delay

Long time delay varies the time it will take the breaker to trip under a sustained overload condition. This setting permits the breaker to ride through momentary predictable overloads (such as motor starting inrush current) without tripping. Each adjustable rating plug allows adjustment of the delay. Settings range from 1.25 to 10 seconds (at 7.2 times the rating plug ampacity).

Long-time Delay with Motor Protection

Also included in the long-time delay is a motor protection mode. When set to motor protection mode, a phase loss protection is initiated that will trip the breaker when the difference in current between one phase current and the other phases exceeds 80% for more than two seconds.

Long-time Load Indicator

The trip unit is equipped with a LT load indicator device that operates by means of an LED indicator located on the trip unit front face. If the load reaches 60% of the set LT pickup value, a green LED will start to blink. When the load reaches 75% or above, the LED will remain on.

Short-time Protection

Adjustable short time protection is standard on SMR2 equipped FG600 breakers. FE250 or FG600 breakers equipped with SMR1 trip units do not include adjustable short-time protection.

Short-time Pickup

The short-time pickup function controls the level of high current the circuit breaker will withstand for a short period of time, to allow downstream devices to clear faults. Settings are adjustable from 1.5-10 times (for breakers with 400A or 600A CT's) or 1.5-12 times (for 250A CT breakers) the Long-Time pickup setting.

Short-time Delay

Short-time delay provides additional refinement in providing coordination between upstream and downstream protection devices. Short time delay is adjustable to five delay bands, of 40 - 420 msec, each available with i2t "ON" or "OFF".

Selectable short-time i2t helps the solid-state trip unit in the FG breaker coordinate with downstream thermal-magnetic devices or fuses that respond to energy flowing in a circuit. This function impacts the shape of the short-time and short-time delay curves.

Instantaneous Protection

Adjustable instantaneous protection is standard on SMR1 and SMR2 trip units.

Instantaneous Pickup

The instantaneous trip point establishes the value of current that will trip the breaker without any intentional time delay. Instantaneous trips are the result of severe overcurrent or short circuit conditions. The goal of instantaneous tripping is to minimize the damage to the electrical system by interrupting the flow of current as quickly as possible. Adjustments are made in multiples of the breaker's CT rating. For all FE250 breakers and for FG600 breakers with 400A or 600A CT's, adjustments range from 2 - 13 times the CT rating. For FG600 breakers equipped with 400A and 600A CT's, adjustments from 2-11 times the CT rating are possible. The maximum adjustment point is limited to not exceed the breaker's withstand capability, thereby preventing internal damage to the circuit breaker.

Ground Fault Protection

Ground fault protection is available on SMR2 equipped FG600 circuit breakers via a *separately ordered and user installed* expansion module.

A ground fault is an unintentional current flow from a circuit through a conductive path to ground. Ground faults usually have intermittent or very low values of current flow and are often not detected by the long-time overload protection of the circuit breaker.

Ground Fault Pickup

When equipped with ground fault protection, the breaker will continually monitor the vector sum of the three phase currents (and the neutral conductor if equipped with a neutral CT). Ground fault pickup is adjustable on the expansion module, with settings that range from 0.2 to 1.0 times the breaker's CT rating.

Ground Fault Delay

Ground fault delay, in a manner similar to short-time delay, is adjustable to allow for coordination between upstream and downstream devices. Ground fault delay can be set to one of five bands, with delays of 40-420 msec, and like short-time delay includes the option to include or exclude i2t curve shaping to enhance coordination with energy responsive devices such as thermal-magnetic circuit breakers.

Ground Fault Alarm

Ground fault alarm offers the same adjustability and settings as ground fault protection, with the exception that upon activation of the protection, an alarm signal (via contact closure) is given instead of breaker tripping. A 100mA / 240V NC contact is included in the module and can be wired out through the 12 pole connector plug on the breaker.

Neutral Current Sensors

When a ground fault (alarm or trip) expansion module is added to an SMR2 trip unit that is being used on a single phase 3-wire or a three phase 4-wire system (e.g., 120/208 or 480/277) is used, an external neutral sensor must be inserted into the neutral lead of the power system in order to complete the ground-fault protective circuit. These must be ordered separately using the following catalog numbers:

Product No.	Description
FGGS0250	250A Neutral Sensor
FGGS0400	400A Neutral Sensor
FGGS0600	600A Neutral Sensor

Ground fault protection with 3- and 4- wire systems and external neutral sensors are not compatible with resistance grounded or corner grounded delta systems.

Zone Selective Interlocking

Zone selective interlocking is available on SMR2 equipped FG600 breakers. This option must be ordered on the breaker and cannot be user defeated. SMR2 ZSI is also compatible with both GE MicroVersaTrip and EntelliGuard TU trip units, when combined with a TIM1 module.

This optional feature allows the user to maintain the selectivity of a coordinated system while providing the fastest possible reaction time to a fault. When ZSI is present, the SMR2 trip unit will always trip the breaker as quickly as possible, ignoring the time delays set by means of the STD or GFD settings. When a ZSI restraint signal is received from a downstream breaker, however, the STD or GFD of the upstream device will take precedence. The ZSI option requires a 24VDC auxiliary supply. A communications module (FAMECM) connected with one of the breakers in the loop can be used to communicate ZSI occurrences for breakers equipped with a communications module.

Trip Units and Protections – SMR2

SMR2 Expansion Modules

Each SMR2 trip unit can be equipped with two plug-in elements, a rating plug and an expansion module. The expansion modules are simple plug-in devices that allow the user to enhance the SMR2 as a protective device or to add extra functional features. Each module has a low level electronic output that can be channeled through the communication device (when present) or in some cases, trigger a 1A/250V change-over contact in the external contact module (FAMECM). By default, the breaker will be supplied with a filler module FAMB2 (below).



Module FAMGFT2
Ground Fault protection + Trip Reason Indication



Module FAMGFM2
Ground Fault protection + Communications



Module FAMGFS2
Ground Fault protection + Load Shedding Device



Module FAMAM2
Ammeter



Module FAMGAT2
Ground Fault Alarm + Trip Reason Indication



Module FAMGAM2
Ground Fault Alarm + Communications



Module FAMGAS2
Ground Fault Alarm + Load Shedding Device



Module FAMSM2
Load Shedding Device + Communications



Module FAMMT2
Communications + Trip Reason Indication



Module FAMST2
Load Shedding Device + Trip Reason Indication



Module FAMB2
Spare filler module



Module FAMECM2
External, DIN-rail mounted device, required for communications. Also serves as contact module for load shedding.

Load Shedding Device

The load shedding device is designed to allow the user to switch off non-priority loads before the LT function trips the breaker due to overload. The device has two channels, both adjustable from .55 to 1.0x the set LT protection value. Each channel is equipped with a delay that is directly proportional to that of the LTD setting. Channel 1 is set to a delay of LTD/2, and channel 2 is set to LTD/4. When the current drops below the pickup setting, the signal is reset. A signal due to load shedding pickup can be channeled through the communication output or wired to the external contact module FAMECM.

Trip Reason Indication

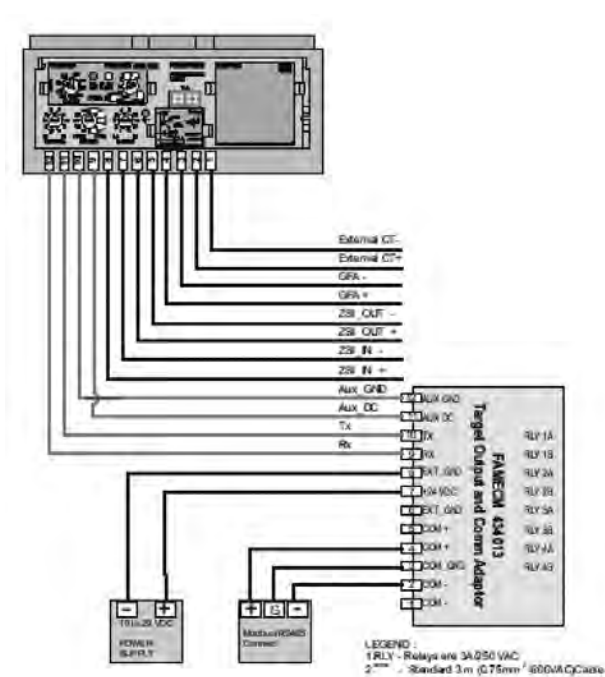
A set of three LED's (one each for LT, ST and I) indicates the reason for a breaker trip. Without auxiliary power, pressing the trip reason pushbutton will be required for indication. When the breaker is supplied by an external 24VDC source, trip reason indication will happen immediately upon an overcurrent operation. A battery module supplied with the trip unit is required for LED indication. A replacement battery module (FAMBAT) is available.

Overtemperature Protection

All SMR2 trip units have built-in temperature sensors that trip the breaker at internal temperatures above 90°C. The thermal memory tracks overheating, even after the device has tripped, and prevents the breaker from being switched on in environments above 90°C. A battery module (supplied with the trip unit) is required to enable this function. Replacement battery modules (FAMBAT) are available.

Communications

Communicates breaker information including the following: Phase currents, position of all switches on the breaker, trip reason indication, load shedding signals, and zone selective interlock occurrences. For each breaker with Modbus RTU, the use of an internal communications module and an external contact module FAMECM is required. The FAMECM external contact module requires an external 24VDC power supply. For a complete list of communicated parameters, register map, and instructions, please see DEH-41181, the SMR2 Modbus User Manual.



Connections from SMR2 Trip Unit to FAMECM Communications Module

Ammeter

The ammeter provides the user with a measure of the current flowing through one of the breaker phases. The device has an accuracy of +/- 10% of full scale, and by default displays the current flowing through the most heavily loaded phase. Pushbuttons allow the user to scroll between phases.

External Power Supply

Communications and Zone Selective Interlocking both require an external 24VDC power supply. An external supply will also enable automatic display of trip reason indication. A power supply assembly is available for AC supply voltages of 85-240VAC. The input to this assembly should be protected with 1/2A class CC fuses.

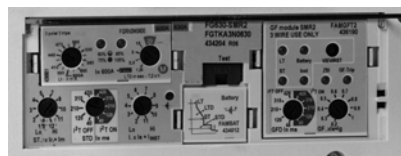
Power supply plate assemblies are also available, which include fuse protection and enable supply voltages above 240VAC.

Description	Input Voltage (VAC)	Product Number
Power Supply Assembly	85 - 240	SPSAA
Power Supply Plate (Includes Fuses)	120	SPSA120
	208	SPSA208
	240	SPSA240
	480	SPSA480
	600	SPSA600



SMR1 ETU (FE250 & FG600)

Frame	Max Amps (CT Rating)	L		I
		Long time pick-up (x Rating Plug)	Long time delay	Instantaneous Trip (x Sensor Rating)
FE250	25, 60, 125, 150, 250	Fixed (1 x Plug)	Fixed	2, 3, 4, 5, 6, 7, 8, 9.5, 11.5, 13.5
	250	Fixed (1 x Plug)	Fixed	2, 3, 4, 5, 6, 7, 8, 9.5, 11.5, 13.5
FG600	400	Fixed (1 x Plug)	Fixed	2, 3, 4, 5, 6, 7, 8, 9, 10, 11
	600	Fixed (1 x Plug)	Fixed	2, 3, 4, 5, 6, 7, 8, 9, 10, 11



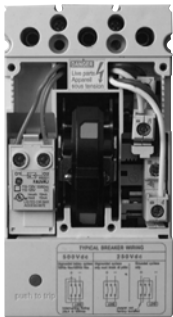
SMR2 ETU (FG600)

Max Amps (CT) Rating	Rating Plug	L		S		I	G	
		Long time pick-up	Long time delay	Short time pick-up	Short time delay	Instantaneous Trip	Ground fault pick-up	Ground fault delay
		Pickup (Amps)	Sec. @7.2 x Plug	x LT Setting	msec	x CT Rating	x CT Rating	msec
250	160	100, 104, 108, 112, 116, 120, 124, 128, 132, 136, 140, 144, 148, 152, 156, 160	1.25, 2.5, 5, 10, 20*, 30*	1.5, 2, 3, 4, 5, 7, 9, 10, 11, 12	40, 120, 210, 310, 420; i2t On, i2t Off	2, 3, 4, 5, 6, 7, 8, 9.5, 11.5, 13.5	.2, .3, .4, .5, .6, .7, .8, .9, 1.0	40, 120, 210, 310, 420; i2t On, i2t Off
	250	155, 165, 170, 175, 180, 190, 195, 200, 205, 215, 220, 225, 230, 240, 245, 250						
400	250	160, 165, 175, 180, 185, 190, 200, 205, 210, 220, 225, 230, 235, 245, 250	1.25, 2.5, 5, 10, 20*	1.5, 2, 3, 4, 5, 6, 7, 8, 9, 10	40, 120, 210, 310, 420; i2t On, i2t Off	2, 3, 4, 5, 6, 7, 8, 9, 10, 11	.2, .3, .4, .5, .6, .7, .8, .9, 1.0	40, 120, 210, 310, 420; i2t On, i2t Off
	400	250, 260, 270, 280, 290, 300, 310, 320, 330, 340, 350, 360, 370, 380, 390, 400						
600	600	395, 410, 425, 440, 460, 475, 490, 505, 520, 535, 550, 565, 585, 600	1.25, 2.5, 5, 10, 20*	1.5, 2, 3, 4, 5, 6, 7, 8, 9, 10	40, 120, 210, 310, 420; i2t On, i2t Off	2, 3, 4, 5, 6, 7, 8, 9, 10, 11	.2, .3, .4, .5, .6, .7, .8, .9, 1.0	40, 120, 210, 310, 420; i2t On, i2t Off

* - Motor Application w/ Phase Loss

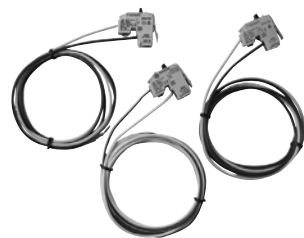
** - Available on Ground Fault Trip, not Ground Fault Alarm

Internally Mounted Accessories



Record Plus internal accessories are common across the family, and are installed in specially designed sockets behind the front cover that allow installation without exposure to current carrying parts. Upon removal of the front cover, the breaker trips and will remain tripped until the cover is replaced. The sockets are accessed by removing the breaker front cover (held on by standard hardware). The sockets and accessories are labeled with distinctive markings to indicate into which pocket a particular accessory can be installed. One must only match the symbol on the accessory to the symbol on the breaker to install the accessory in the correct location.

Shunt Trip & Undervoltage Release



Shunt trip, bell alarm and auxiliary switch

The shunt trip is used to remotely open the circuit breaker. Like all other accessories, the shunt trip is UL listed for field installation and does not require exposure to current carrying parts for installation. Both the shunt trip and Undervoltage Release are low power consumption devices. Record Plus breakers feature a kiss-free design, which ensures that the primary contacts do not come into contact when a closing attempt is made with a shunt-trip or undervoltage release energized.

The undervoltage release is used to trip the circuit breaker when a control signal is removed, or drops below 35 – 70% of the rated voltage. If an attempt is made to re-close the circuit breaker without re-application of control power to the undervoltage release, the breaker will be held trip-free, preventing the contacts from closing.

It is not possible to install both an undervoltage release and shunt trip in the same breaker.

Configuration	Voltage	Shunt Trip		Undervoltage Release	
		Cat. No.	Inrush Power	Cat. No.	Inrush Power
	12 VDC	FASHTBW	200 mA / 2.4 W	-	-
	24 VAC / VDC	FASHTDW	100 mA / 3.6 W	FAUVRDW	50 mA / 1.2W
	48 VAC / VDC	FASHTFW	60mA / 2.88 W	FAUVRFW	20 mA / 0.96W
	110-130 VAC / 110-125 VDC	FASHTJW	40 mA / 4.8 W	FAUVRJW	15mA / 3.45W
	120 VAC*	FASHTKW	40 mA / 4.8 W	-	-
	220-240VAC / 250VDC	FASHTNW	20 mA / 4.6 W	FAUVRNW	15mA / 3.45W
	277 VAC	FASHT7W	11 mA / 3.0 W	FAUVR7W	15mA / 4.0W
	400-480 VAC	FASHTUW	20 mA / 8.4 W	FAUVRUW	15mA / 6.3W

*FASHTKW Suitable for use with external ground fault sensing and relaying equipment (Operable at 55% of Rated Voltage)

Each shunt trip or undervoltage release is supplied with two #16 leads, 34" long. Blue for undervoltage releases, black for shunt trips.

Bell Alarm & Auxiliary Switch

The Bell Alarm switch is used to signal a breaker trip operation. Common uses for bell alarm switches include indicating lights, external control relays, interlocking schemes, and any other application that requires remote indication of breaker trip. The switches are available in either normally open (NO) or normally closed (NC) configuration. Auxiliary switch contacts change position due to any operation of the circuit breaker (overcurrent trip, push to trip from the front cover, shunt trip/undervoltage release or toggle handle operation). Bell alarm contacts do not change position due to an operation of the toggle handle or push to trip button.

The auxiliary switch provides remote indication of the primary contact position. Auxiliary switches are commonly used anywhere remote indication of breaker position is desired. These switches are available in normally open (NO) and normally closed (NC) configurations; the contacts change position upon changing of position of the primary contacts regardless of method of operation.

Contact Configuration		Description / Catalog Number		Wire Color
1 NO (Form A)		Bell Alarm	FABAM10W	Yellow - Brown
		Aux Switch - Left Mounted	FAS10LW	White - Red
		Aux Switch - Right Mounted	FAS10RW	White - Red
1 NC (Form B)		Bell Alarm	FABAM01W	Yellow - Purple
		Aux Switch - Left Mounted	FAS01LW	White - Brown/White
		Aux Switch - Right Mounted	FAS01RW	White - Brown/White

All auxiliary and bell alarm switches are supplied with 34" of #16 wire, rated 600V.

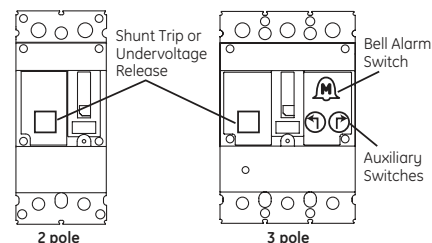
Switch ratings are as follows:

24VAC – 10A	24VDC – 2.5A
120VAC – 6A	125VDC – 0.55A
277VAC – 1.9A	250VDC – 0.27A

Accessory Mounting Locations and Limitations

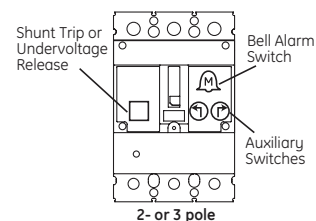
FB 100

Accessory	Mounting Pocket Location	Accessory Installation		
		1 Pole	2 Pole	3 Pole
Shunt Trip or Undervoltage Release		0	1	1
Aux. Switch - Left Mount		0	0	1
Aux. Switch - Right Mount		0	0	1
Bell Alarm		0	0	1
Max. Number of Internal Accessories		0	4	4



FC 100

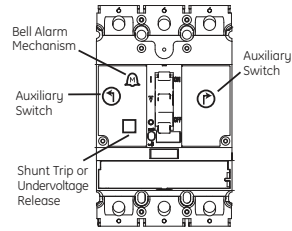
Accessory	Mounting Pocket Location	Accessory Installation	
		2 Pole*	3 Pole
Shunt Trip or Undervoltage Release		1	1
Aux. Switch - Left Mount		1	1
Aux. Switch - Right Mount		1	1
Bell Alarm		1	1
Max. Number of Internal Accessories		4	4



*2 Pole breaker in 3 Pole envelope

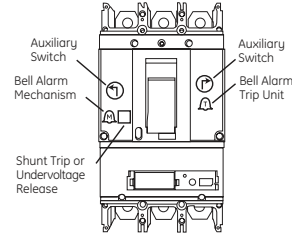
FE 250

Accessory	Mounting Pocket Location	Maximum Quantity
Shunt Trip or Undervoltage Release		1
Aux. Switch - Left Mount		2
Aux. Switch - Right Mount		2
Bell Alarm Mechanism		1



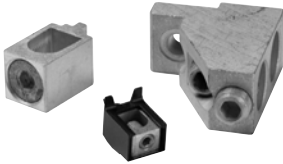
FG 600

Accessory	Mounting Pocket Location	Maximum Quantity
Shunt Trip or Undervoltage Release		1
Aux. Switch - Left Mount		3
Aux. Switch - Right Mount		2
Bell Alarm Mechanism		1
Bell Alarm Trip Unit		1



External Accessories

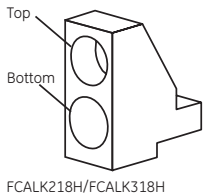
Termination Lugs



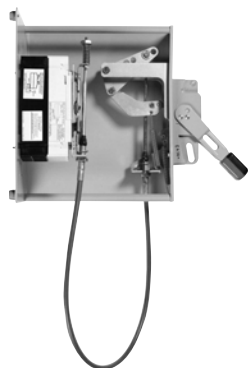
Termination lugs are available with / for Record Plus breakers that permit easy front connection of copper or aluminum insulated conductors to the breaker terminals. Lugs for FB, FC and FE frames are snap-in lugs that are held captive without hardware for ease of installation. FG lugs are mechanically attached to the circuit breaker terminals to provide sturdy connection of larger conductors.

Frame	Amp Range	Wire Range	Lug Part Number	Lug Kit (Set of 3) Part Number	Torque Specification	Lug Kit (Set of 3) w/ Control Wire Terminal
FB 100 / FC 100	15-20 A	14-10 Cu / Al	FCAL12	FCALK12	25 - 32 in*lb	
	25 - 60 A	10-4 Cu / Al	FCAL13	FCALK13	25 - 32 in*lb	
	70 - 100 A	4 - 1/0 Cu / Al	FCAL14	FCALK14	25 - 32 in*lb	
FE 250	20 - 150 A	14 - 3/0 Cu / Al	FCAL15	FCALK15	150 in*lb	FCALK15LV
	175 - 250A	#8 - 250 Cu / #8 - 350 Al	FCAL16	FCALK16	275 in*lb	FCALK16LV
FG 600	100- 600	#8 - 400 Cu / #6 - 500Al (Top*)	(Set of 3) FCALK318H		#8 - #4 275 in*lb	
		2/0 - 600 Cu / Al (Bottom*)	(Set of 2) FCALK218H		#3 - 600 375 in*lb	

*Top/Bottom holes in lug as shown



Cable Operators



The FC100 and FE250 frames are available with an assortment of accessories designed to operate the breaker from the outside of an enclosure. Cable operators allow the ultimate in flexibility between operator and breaker placement, STDA type operators allow a more rigid connection between the breaker and a handle operator located in front of the breaker, usually on a door flange, and TDM and TDR type handle operators provide close access to the toggle handle of the breaker, while offering closed door operation.

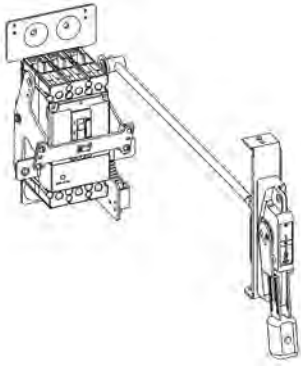
Cable operating mechanisms are suitable for application with FC100 and FE250 breakers mounted in a wide variety of flanged enclosure types and sizes. The force and motion for breaker operation is transmitted independently of the breaker mounting plane. It is important to note that with the cable operator and breaker installed, a minimum 3 inch bending radius is allowed in the cable. Instruction bulletin DEH-40912 includes dimensional information for mounting holes and a guide on how to size the cable to avoid bend radii smaller than 3 inches.

Cable operators consist of three parts which must be ordered separately:

- 1. Handle Mechanism** Flange-mounted handle mechanisms (which are available for NEMA types 1, 12 or 13 enclosures in either 6 inch or 12 inch handle lengths).
- 2. Cable** The cable links the handle mechanism to the breaker mechanism and is available in 7 cable lengths, ranging from 3 to 10 feet.
- 3. Breaker Mechanism** The breaker operating mechanism mounts directly to the face of the breaker and does not involve any mounting interface with the enclosure. The breaker mechanism is supplied with standard mounting screws for mounting the breaker to tapped holes in the enclosure.

Breaker	Cable	Breaker Mechanism	Handle Mechanism (6 Inch)		Handle Mechanism (10 Inch)	
			NEMA 1, 3R, 12, 13	NEMA 4 / 4X	NEMA 1, 3R, 12, 13	NEMA 4 / 4X
FC100	SC3L, SC4L, SC5L, SC6L, SC7L, SC8L, SC9L, SC10L	FCNBM	FCNHM1	FCNHM3	FCNHM2	FCNHM4
FE250	SC3L, SC4L, SC5L, SC6L, SC7L, SC8L, SC9L, SC10L	FENBM				

Flange Mounted Variable Depth Operators



STDA type operating handles and breaker mechanisms provide a flange-mounted handle that provides a more solid connection between the operating handle and the circuit breaker, but still offers enclosure depth flexibility (8 – 12 inches). Using a standard padlock, the handle can be padlocked in the “OFF” position.

The flange handle and operating mechanism must be ordered separately. An assortment of accessories are also available for the STDA type flange mounted handle operators.

Handle Mechanism

The handles are of a rugged die cast construction, with double thick steel handles and large red/black plastic grip. O-ring seals are included for dirt-tight / oil-tight duty. The handles are available in either 6 or 10 inch sizes. Instruction bulletin GEH-5314 includes detailed handle drilling and installation instructions.

Breaker Mechanism

The breaker mechanism kit consists of a cradle which is screw-mounted to the enclosure and a yoke assembly that interfaces with the breaker toggle handle. The breaker mechanism can be quickly re-configured in the field for mounting the handle to the left or right of the circuit breaker. Instruction bulletin DEH-40534 (FC) and DEH-41014 (FE) include detailed drilling and installation instructions, as well as instructions on how to custom-cut the drive rod to a length appropriate for the enclosure.

Breaker	Operating Handle			Breaker Operating Mechanism	Flange Stiffener / Extended Drive Rod	Extended Drive Stud	Door Interlock Hardware Kits			
	NEMA 12/13	NEMA 4/4X	Length				Door Hinge	NEMA 12/13	NEMA 4 / 4X	3rd Point Latch
FC100	STDA1	STDA1X	6"	FCNFM	TDSR	TDS1	Left	TDV1	TDV1X	TDV3L
	STDA2	STDA2X	10"				Right	TDV1L	TDV1LX	
FE250	STDA1	STDA1X	6"	FENFM	TDSR	TDS1	Left	TDV1	TDV1X	TDV3L
	STDA2	STDA2X	10"				Right	TDV1L	TDV1LX	

Additional Accessories

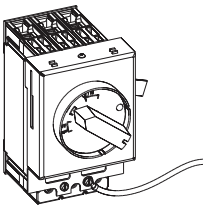
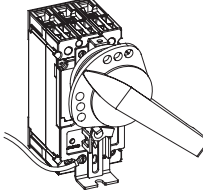
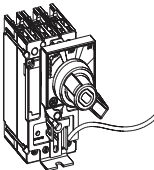
- *Flange Stiffener* – Provides a rigid 3/8" rod between the handle operator and the breaker mechanism for applications where the handle would not otherwise be rigidly supported
- *Extended Drive Rod* – Extends the maximum breaker mounting plane to handle mounting plane to 18"
- *Extended Drive Stud* – Permits further (by 1 5/16") offset between the operating handle and the breaker mechanism
- *Door Interlock Hardware Kits* – Permits doors to be interlocked to circuit breaker position (Door will open only when the circuit breaker is in the “OFF” position).

Rotary Handles

Type TDR handles are designed for direct mounting to the circuit breaker. A door ring on the handle projects through a hole on the front of the enclosure door. Type TDR handles are suitable for use with shallow depth NEMA1, NEMA12, or NEMA12K enclosures.

Type TDM handles are designed for door mounting of the rotary handle. Shafts of various lengths connect directly to a sliding plate assembly that fits over the toggle handle on the circuit breaker. The rotary motion of the handle opens or closes the circuit breaker.

Record Plus style handles are also designed for door mounting of the rotary handle and utilize a shaft for connection to the circuit breaker toggle handle. 1-3 padlocks can be installed in both Record Plus style and TDM style rotary handles to comply with lock-out / tag-out requirements. The Record Plus style handles offer a more modern appearance while providing rotary handle actuation of the circuit breaker.

Handle Type	Record Plus	Description		Cat. No.	
 TDR	FC100	Vertical	Standard (4")	FCNRC	
			Narrow (3")	FCNRCN	
			Narrow (Non-Interlocked)	FCNRCNI	
		Horizontal	Standard (4")	FCNRD	
		Interlocking Kit		FCFRDRCK	
			Gasket	SEFRGSK	
	Instruction Sheet			DEH-40914 DEH-40919	
	FE250	Vertical	Non-Interlocked		FENRC FENRCI
			Horizontal		FENRD
		Interlocking Kit		SEFRDRCK	
Gasket			SEFRGSK		
Instruction Sheet			DEH-41028 GEI-70594		
 TDM	FC100	Shallow Door (5" Enclosure Depth) Mount		FCNRM2	
		Extended Shaft Door (Variable Enclosure Depth) Mount		FCNRM4	
		Handle Kit (order separately from door mount)		THCH45	
		Instruction Sheet		DEH-40913	
	FE250	Shallow Door (5" Enclosure Depth) Mount		FENRM2	
		Extended Shaft Door (Variable Enclosure Depth) Mount		FENRM4	
		Handle Kit (order separately from door mount)		THCH45	
		Instruction Sheet		DEH-41027	
	 Record Plus Type	FC100	Shallow Door (5" Enclosure Depth) Mount with Handle		FCNRN
			Extended Shaft Door (Variable Enclosure Depth) Mount with Handle		FCNRT
Shallow Door (5" Enclosure Depth) Mount			FCNRM1		
Extended Shaft Door (Variable Enclosure Depth) Mount			FCNRM3		
Instruction Sheet			DEH-40517		
FE250		Shallow Door (5" Enclosure Depth) Mount with Handle		FENRH	
		Extended Shaft Door (Variable Enclosure Depth) Mount with Handle		FENRT	
		Shallow Door (5" Enclosure Depth) Mount		FENRM1	
		Extended Shaft Door (Variable Enclosure Depth) Mount		FENRM3	
		Instruction Sheet		DEH-41025	

Functions and Advantages

General

Molded Case Circuit Breakers

Molded case circuit breakers are circuit protective devices that perform two primary functions. 1) automatic opening of the circuit breaker under overcurrent conditions, 2) opening/closing of a circuit by non-automatic means.

Functions

A circuit breaker inherently protects circuits during short circuit and overload conditions by automatically opening its protected electrical circuit without the use of fuses. When the circuit breaker opens to clear a short circuit or a sustained overload condition, its toggle handle moves to the tripped position (midway between open and closed), indicating that the circuit breaker has automatically opened. Once the situation causing the overload or short circuit has been corrected, the circuit breaker may be reset by moving the toggle handle completely to the 'off' position before returning the handle to the 'on' position.

Circuit Breaker Advantages

There are several advantages to the use of circuit breakers as protective devices. One key advantage to circuit breakers is that an overcurrent condition on a single pole of a circuit breaker will result in the opening of all poles simultaneously. When using fusible devices for overcurrent protection, it is possible that an overcurrent on a single pole will result in opening of that phase only, thereby creating a phase imbalance that can potentially damage downstream equipment.

Molded Case Circuit Breakers (MCCB's) are designed to be inherently trip-free when an overcurrent condition exists, or when an external tripping signal is being applied. Simply stated, if conditions exist such that the breaker should be open, it will not close, even if the toggle handle is forced into the 'ON' position.

Protection

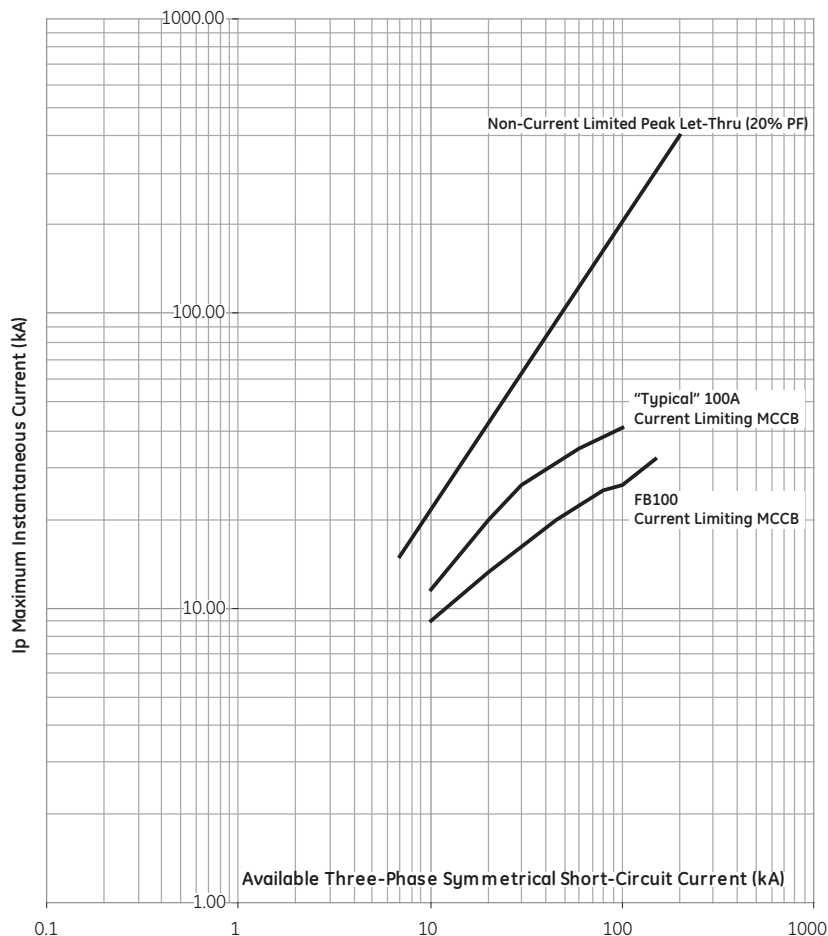
Record Plus breakers utilize a unique combination of design features to offer the ultimate combination of protections in demanding electrical systems.

Current Limitation

Design features such as double break rotary contacts and reverse loop current paths make Record Plus among the most current limiting circuit breakers on the market today. When subjected to short circuit currents, the contacts are designed to "blow open" in response to the peak current levels. This mode of operation limits the amount of energy delivered to faulted conductors and downstream equipment to a fraction of that available. As an example, on a 480V system subjected to a 100kA fault (with a .2 power factor) will subject connected conductors and equipment to a peak current in excess of 200kA. With a current limiting FB circuit breaker, the peak current will be limited to less than 30kA.

The current limiting behavior of Record Plus breakers can benefit a user in three ways:

1. The reduced let-thru energy can translate into reduced requirements for protection of personnel servicing the electrical equipment and can potentially reduce HRC levels.
2. Current limitation during a short circuit event can allow Record Plus breakers to 'help' downstream devices clear faults they might not previously have been able to clear. See DET-008 for series ratings information including Record Plus breakers.
3. Current limitation, coupled with fast-acting but intelligent trip units, make Record Plus ideal for applications requiring total selectivity. A system employing Record Plus breakers has unprecedented potential to be both safe (reduced arc flash energy) and reliable (selective, even at instantaneous levels).



Full Let-thru Curves for Record Plus Circuit Breakers:

Type	Peak Let-Through	I ² T Let-Through
FB100	DES-030	DES-031
FC100	DES-030	DES-031
FE250	DES-205	DES-206
FG600	DES-040	DES-041

Basis of Interrupting Ratings

Short Circuit Current

Interrupting ratings depend upon knowing the magnitude of the short circuit current that may flow through the circuit breaker. Devices rated in accordance with UL Standard 489 list their interrupting rating in terms of rms symmetrical amps. Devices rated in accordance with the IEC Standard 947-2 list both a “rated ultimate short circuit breaking capacity (I_{cu})” and a “rated service short circuit breaking capacity (I_{cs})” both in terms of rms symmetrical amps.

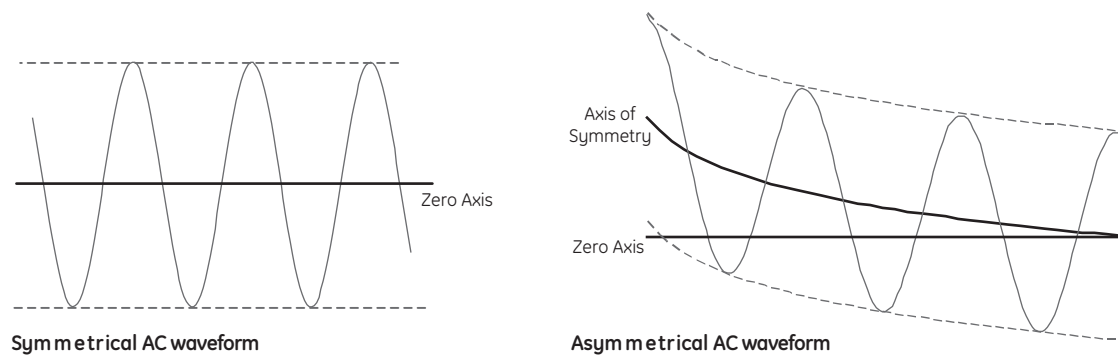
Differences between the IEC947-2 values of I_{cu} (ultimate) and I_{cs} (service) breaking capacities are based upon specific ratios of I_{cs} to I_{cu}, depending upon a number of factors, including whether the protective device is intentionally designed to incorporate time delay to provide selectivity to the protection system.

The procedures for calculating short circuit current and the X/R ratios are described in detail in GE Publication GET-3550.

Generally, electrical power system engineers calculate the X/R ratios rather than the power factors of protected circuits during short circuit studies. The magnitude of the momentary peak current to be interrupted is a function of the maximum peak current displacement from the zero current axis. That displacement is a function of the X/R ratio, the lower the power factor, the greater the magnitude of peak displacement.

Interrupting ratings of molded case circuit breakers are based upon a specific ratio of reactance to resistance, or a specific power factor. Since practical ac circuits contain some reactance, there is some displacement between current and voltage waveforms. Because a short circuit can literally occur during any point of the voltage wave, an actual trace of short circuit current may display considerable initial displacement from the zero axis.

In the figure below, the waveform at left shows a symmetrical ac current waveform that would occur if a purely resistive circuit was short circuited (or even a circuit containing reactance if the short circuit occurred at a precisely the right point in the voltage waveform, which is unlikely).



The waveform on the right is a current trace of a short circuited ac circuit where displacement about the zero axis exists as a consequence of when the short circuit is applied and the amount of reactance in the short circuited circuit, compared to its resistance.

There is a simple relationship between the power factor of a short circuit and its X/R ratio. It is $PF \text{ (in \%)} = R/Z \times 100$
And $Z = \sqrt{R^2 + X^2}$

Therefore:

$$PF = (R / (R^2 + X^2)) \times 100$$

The following table shows derating factors that must be applied to the maximum interrupting rating of Record Plus breakers when applied at varying power factors.

For example, a 65kA rated FB breaker, applied at any power factor greater than 20% need not be derated.

A 65kA rated FB breaker, applied at a power factor of 10% would have an adjusted interrupting rating of $65 \times .88 = 57.2 \text{ kA}$

Power Factor (%)	X / R Ratio	Max. Interrupting Rating		
		1-10 kA	11 - 20 kA	21 + kA
4	24.980	0.60	0.72	0.81
5	19.974	0.62	0.74	0.82
6	16.637	0.63	0.75	0.83
7	14.251	0.64	0.76	0.84
8	12.460	0.65	0.77	0.85
9	11.066	0.66	0.78	0.87
10	9.950	0.67	0.79	0.88
11	9.036	0.68	0.80	0.89
12	8.273	0.69	0.81	0.90
13	7.627	0.69	0.82	0.91
14	7.072	0.70	0.83	0.93
15	6.591	0.71	0.84	0.94
16	6.169	0.72	0.85	0.95
17	5.797	0.73	0.85	0.96
18	5.465	0.74	0.87	0.97
19	5.167	0.75	0.88	0.98
20	4.899	0.76	0.89	1.00
21	4.656	0.77	0.90	1.00
22	4.434	0.77	0.91	1.00
23	4.231	0.78	0.92	1.00
24	4.045	0.79	0.94	1.00
25	3.873	0.80	0.95	1.00
26	3.714	0.81	0.96	1.00
27	3.566	0.82	0.97	1.00
28	3.429	0.83	0.98	1.00
29	3.300	0.83	0.99	1.00
30	3.180	0.84	1.00	1.00
31	3.067	0.85	1.00	1.00
32	2.961	0.86	1.00	1.00
33	2.861	0.87	1.00	1.00
34	2.766	0.88	1.00	1.00
35	2.676	0.88	1.00	1.00
36	2.592	0.89	1.00	1.00
37	2.511	0.90	1.00	1.00
38	2.434	0.91	1.00	1.00
39	2.361	0.91	1.00	1.00
40	2.291	0.92	1.00	1.00
41	2.225	0.93	1.00	1.00
42	2.161	0.94	1.00	1.00
43	2.100	0.95	1.00	1.00
44	2.041	0.95	1.00	1.00
45	1.984	0.96	1.00	1.00
46	1.930	0.97	1.00	1.00
47	1.878	0.97	1.00	1.00
48	1.828	0.98	1.00	1.00
49	1.779	0.99	1.00	1.00
50	1.732	1.00	1.00	1.00

Blow-Open Contacts

All Record Plus breakers feature current limiting construction that, under short circuit conditions, will provide opening of the breaker in a sufficiently rapid manner as to affect the current flow during the first ½ cycle of short circuit current. The contact arms and rotary contact structure are constructed so that under short circuit current, the contacts are propelled apart by the current itself. When short circuit current flows through the contact structure, forces proportional to the square of the current act to 'blow open' the moving contact arms. The higher the fault current, the higher the force. During maximum fault conditions, contact separation typically occurs within four milliseconds and the arc is typically fully quenched within 8 milliseconds.

Peak let-thru current is typically held to less than 45% of the maximum available peak current, resulting in a tremendous reduction in the amount of energy delivered to conductors and associated equipment.

Thermal-Magnetic Trip Units

Thermal-magnetic trip units that are compact and cost efficient provide the protection functions for the FB100 and FC100 trip units. The thermal portion of these trip units use a mechanical element composed of dissimilar metals that respond differently to temperature. The mechanical / thermal nature of these elements make them inherently immune to electrically noisy circuits such as those with a high level of harmonic distortion.

The magnetic elements in these thermal-magnetic trip units provide the overcurrent protection during a short-circuit. The capability of an electromagnet to respond differently depending upon the amount of current flowing through it is utilized to produce a mechanical motion that is proportional to the current. The mechanical motion of the magnet is then used to operate the circuit breaker mechanism thereby causing the contacts to open.

Electronic Trip Units

Electronic trip units that offer sophisticated protective functions and wide setting bands are standard protection devices for the FE250 and FG600 frame sizes. Each electronic device has been designed with the abnormalities of modern low voltage distribution circuits in mind and has been rigorously tested to cope with harmonic currents, electromagnetic fields, inrush currents and spikes, thus preventing phenomena such as incorrect current measurement and nuisance tripping. The devices exist in multiple performance tiers, the SMR1 for the FE and FG frames, and the SMR2 for the FG 600 frames.

The advent of cost effective microprocessors has enabled manufacturers of molded case circuit breakers to offer products containing solid-state trip units. There are a number of advantages to using solid-state circuitry in the trip circuitry of a circuit breaker. These advantages include:

- Higher levels of accuracy in establishing specific tripping points
- Ability to shape instantaneous, short time, and long time tripping current versus time curves to obtain better protection, better selectivity, or both
- Ability to provide better user adjustment of tripping points
- Ability to provide sensing and tripping circuitry that is ambient insensitive

These advantages are generic to any well-engineered molded case circuit breaker and solid state tripping system. The accuracy and flexibility of these trip units make them the logical choice where coordination and accurate protection are required.

RMS Sensing and Peak Sensing

Many modern electrical loads (from computers and fax machines to variable frequency drives) are capable of applying harmonic distortion to the electrical distribution system. In fact, harmonics can even be transmitted between facilities and affect equipment in nearby locations.

As an example, consider the waveform in Figure A. It represents an ideal 60 Hz waveform with a 150A peak. A trip system based on either RMS or peak sensing would measure this waveform and compute a 150A peak, and a RMS value of about 105A. With a long-time pickup set, for example, at 110A, both the RMS sensing and peak sensing trip unit would provide adequate protection.

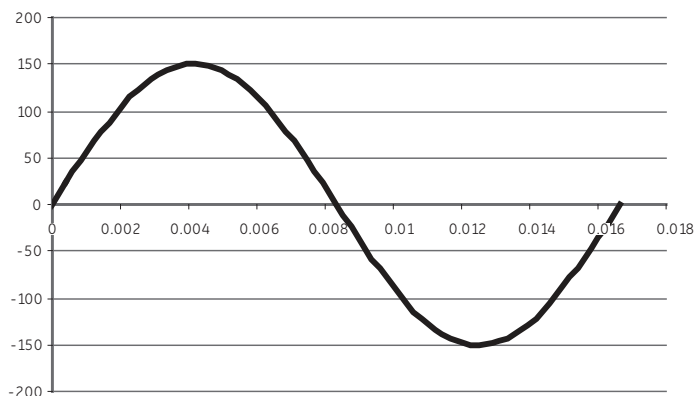


Figure A
60Hz waveform

Next, consider the waveform in Figure B. It represents the same 60Hz waveform, but this time with a 10% fifth harmonic imposed on it. In this case, a peak sensing trip system would accurately detect a peak level of 165A, and from that level would calculate an RMS value of about 117A. The RMS sensing trip unit would, however, detect the same peak of 165A, but would more accurately detect an RMS value of around 105A. The same long-time pickup at 110A from Figure A above would result in a nuisance trip on a peak sensing trip system, while a RMS sensing trip system would not trip. The peak sensing trip system in this case would provide “overprotection” and nuisance trip.

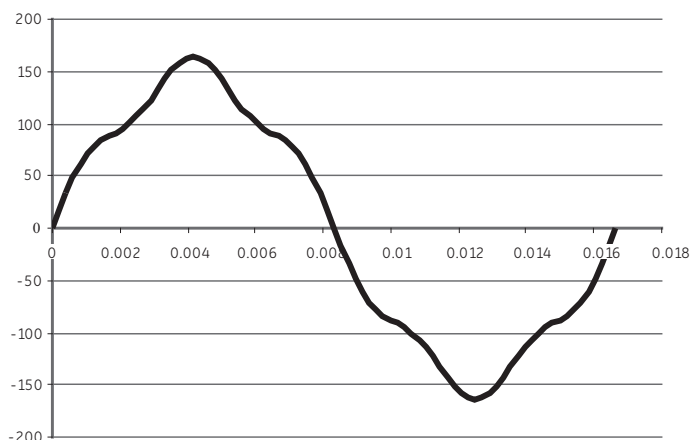


Figure B
60Hz waveform with a 10% fifth harmonic

Finally, consider the waveform in Figure C. Once again, the base signal is the same 60Hz waveform as in Figure A. In this case, however, a 20% third harmonic is imposed. Suppose a trip system were set to protect the #3 AWG conductors of a 100A load. A peak sensing trip system applied on this system would detect a peak of around 130A, and would calculate an RMS value of around 92A RMS and would not trip. A RMS sensing trip system would detect the same 130A peak, but would more accurately detect an RMS value of around 106A and initiate a trip and protect downstream equipment. The peak sensing trip system in this case would provide “underprotection” and not trip appropriately.

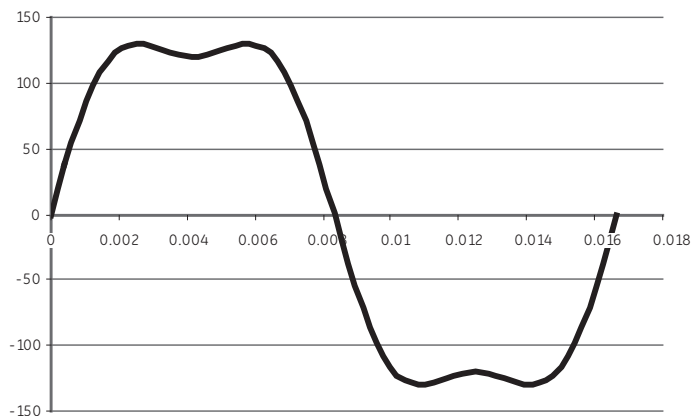


Figure C
60Hz waveform with a 20% third harmonic

The use of quick and accurate components in SMR1 and SMR2 trip systems that sample the waveform at greater than 1800 samples per second allow superior accuracy in determining true RMS current. (A sampling rate of 1620 samples per second results in an error of less than 1% of full scale).

Time-Current Curves

Time current curves are a graphic representation of how a molded case circuit breaker responds to overcurrent conditions. The test parameters for determining time-current curves are as follows:

- The circuit breaker is connected with a minimum of four feet of rated conductor per terminal.
- The circuit breaker is in open air at the indicated ambient.
- All tests are initiated from a zero current condition (referred to as a cold-start).

Information included on the time-current curve typically includes the following:

- Product Family Type
- Specific Device Type
- Amp Ratings on the Curve
- Overcurrent Characteristics – Long-time, Short-time, Instantaneous, etc.
- Maximum Total Clearing Time
- Maximum and Minimum Temperature Limits
- Frequency Ratings
- Voltage Ratings
- Trip Unit adjustment Ranges
- Tolerances

On the time-current curve, current in multiples of the breaker rating (for thermal-magnetic FB100 and FC100 breakers or in amps (for electronic trip FE250 and FG600 breakers) is represented on the horizontal axis and time (in seconds) is represented on the vertical axis. The circuit breaker's range of clearing times for overcurrent conditions is visually represented on the curves by the right edge of the curve for lower currents, and in the inset graph for higher currents.

Time-Current Curve Index

Breaker	Frame	Amps	TCC	Let-Through	
				I _{pk}	I _{2t}
FB / FC	15	15	DES-013	DES-030	DES-031
	20	20	DES-014		
	25	25	DES-015		
	30	30	DES-016		
	35	35	DES-017		
	40	40	DES-018		
	45	45	DES-019		
	50	50	DES-020		
	60	60	DES-021		
	70	70	DES-022		
	80	80	DES-023		
	90	90	DES-024		
	100	100	DES-025		
FE	All	All	DES-200	DES-205	DES-206
FG W/ SMR1	250	100	DES-072	DES-040	DES-041
		110	DES-073		
		125	DES-042		
		150	DES-043		
		175	DES-044		
		200	DES-045		
		225	DES-046		
		250	DES-047		
	400	175	DES-048		
		200	DES-049		
		225	DES-050		
		250	DES-051		
		300	DES-052		
		350	DES-053		
		400	DES-054		
	600	300	DES-055		
		350	DES-056		
		400	DES-057		
		450	DES-058		
		500	DES-059		
		600	DES-060		

Factors affecting current ratings

Many application factors should be considered when selecting the frame and ampere rating of molded case circuit breakers and switches. The following shall be considered herein:

- Size of cable used for line and load connections
- Temperature of the ambient surrounding the breaker or switch
- The altitude at which the device is to be used
- The type of loading on the circuit to be protected
- The design margin of safety
- Derating for continuous loading, if applicable

Operating frequency of the system into which the device is installed can also affect the temperature / current relationship. Record Plus breakers have been designed to operate at 50 / 60 Hz. Design tests outside this range have not been completed.

The six ampere rating factors listed above can be combined into the following equation:

$$I_p = I_a \times A \times B \times C \times D \times E \times F$$

Where:

I_p = Circuit breaker rating (amps)

I_a = Actual load current (amps)

A = Cable Sizing Factor

B = Ambient Temperature Rating Factor

C = Altitude Rating Factor

D = Load Class Rating Factor

E = Factor of Safety

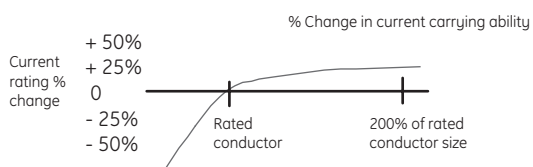
F = Duty Rating Factor

Each of the six factors are quantified in the following pages:

Cable Sizing – Factor A

Molded case circuit breakers are designed to protect insulated cable. The characteristics of breakers are therefore closely tied to Underwriters Laboratories specified size and type of wire for each rating.

The cable size must be equal to or greater than that specified by Underwriters Laboratories Standard for Molded Case Circuit Breakers, UL 489. All GE molded case circuit breakers described in this guide are to be used with 75°C ampacity conductors. The use of 90°C conductors is acceptable, provided they are sized according to the 75°C ampacities. Thermal-magnetic circuit breakers use a resistance element that uses heat to provide a mechanical motion to the circuit breaker operating mechanism. In this case, the cable is part of the thermal system of the circuit breaker; reducing the size of the conductor raises the temperature of the thermal system and reduces the amount of current the circuit breaker can carry. In general, the effect of cable size on breaker thermal calibration is illustrated below.



Record Plus breakers are rated for use with cables rated 60° or 75°C. Higher temperature rated cables are acceptable for use, but must be sized according to 75°C max temperature rating.

Device Ampere Rating	Conductor			
	Copper		Aluminum or Copper Clad Aluminum	
	Paralleled	Size	Paralleled	Size
15 or less	-	14 AWG	-	12 AWG
20	-	12 AWG	-	10 AWG
25	-	10 AWG	-	10 AWG
30	-	10 AWG	-	8 AWG
35	-	8 AWG	-	8 AWG
40	-	8 AWG	-	8 AWG
45	-	8 AWG	-	6 AWG
50	-	8 AWG	-	6 AWG
60	-	6 AWG	-	4 AWG
70	-	4 AWG	-	3 AWG
80	-	4 AWG	-	2 AWG
90	-	3 AWG	-	2 AWG
100	-	3 AWG	-	1 AWG
110	-	2 AWG	-	1/0 AWG
125	-	1 AWG	-	2/0 AWG
150	-	1/0 AWG	-	3/0 AWG
175	-	2/0 AWG	-	4/0 AWG
200	-	3/0 AWG	-	250 kcmil
225	-	4/0 AWG	-	300 kcmil
250	-	250 kcmil	-	350 kcmil
275	-	300 kcmil	-	500 kcmil
300	-	350 kcmil	-	500 kcmil
325	-	400 kcmil	2	4/0 AWG
350	-	500 kcmil	2	4/0 AWG
400	2	3/0 AWG	2	250 kcmil
450	2	4/0 AWG	2	300 kcmil
500	2	250 kcmil	2	350 kcmil
550	2	300 kcmil	2	500 kcmil
600	2	350 kcmil	2	500 kcmil
700	2	500 kcmil	3	350 kcmil
800	3	300 kcmil	3	400 kcmil
1000	3	400 kcmil	3 / 4	350 kcmil / 600 kcmil
1200	3 / 4	350 kcmil / 600 kcmil	4	600 kcmil

Determine any difference between the cross-sectional area of the cable size assigned to the breaker current rating shown in the table above and the cross sectional area of the cable to be used in installation. Then, use the corresponding following multiplying factor to select the correct de-rating factor.

Approximate Correlation, Standard Cross Sections of AWG/kcmil and ISO Metric Cable Sizes

AWG or kcmil size	Equivalent Cross-Section (mm2)	ISO Metric Cable Size (mm2)
18	0.82	0.75
-	-	1
16	1.3	1.5
14	2.1	2.5
12	3.3	4
10	5.3	6
8	8.4	10
6	13.3	16
4	21.2	25
2	33.6	35
1/0	53.5	50
2/0	67.4	70
3/0	85	95
4/0	107.2	-
250	127	120
300	152	150
350	177	185
500	253	240
600	304	300

Properties of Conductors Recommended for Use with Record Plus Molded Case Circuit Breakers

AWG / kcmil Size	Area (Cir. Mills)	Stranded Conductors		Bare Conductors		DC Resistance, Ohms per 1000 ft @ 25C (77F)		
		# of Wires	Diameter of Each Wire (in.)	Diameter (in.)	Area (Square In.)	Bare Conductor	Tinned Conductor	Aluminum
18	1,620	Solid	0.0403	0.0403	0.0013	6.51	6.79	10.7
16	2,580	Solid	0.0508	0.0508	0.002	4.10	4.26	6.72
14	4,110	Solid	0.0641	0.0641	0.0032	2.57	2.68	4.22
12	6,530	Solid	0.0808	0.0808	0.0051	1.62	1.68	2.66
10	10,380	Solid	0.1019	0.1019	0.0081	1.018	1.06	1.67
8	16,510	Solid	0.1129	0.1285	0.013	0.6404	0.659	1.05
6	26,240	7	0.0612	0.184	0.027	0.410	0.427	0.674
4	41,740	7	0.0772	0.232	0.042	0.259	0.269	0.424
3	52,620	7	0.0867	0.260	0.053	0.205	0.213	0.336
2	66,360	7	0.0974	0.292	0.067	0.162	0.169	0.266
1	83,690	19	0.0664	0.332	0.087	0.129	0.134	0.211
1/0	105,600	19	0.0745	0.372	0.109	0.102	0.106	0.168
2/0	133,100	19	0.0837	0.418	0.137	0.0811	0.0843	0.133
3/0	167,800	19	0.0940	0.470	0.173	0.0642	0.0668	0.105
4/0	211,600	19	0.1055	0.528	0.219	0.0509	0.0525	0.0836
250	250,000	37	0.0822	0.575	0.260	0.0431	0.0449	0.0708
300	300,000	37	0.0900	0.630	0.312	0.0360	0.0374	0.059
350	350,000	37	0.0973	0.681	0.364	0.0308	0.0320	0.0505
400	400,000	37	0.1040	0.728	0.416	0.0270	0.0278	0.0442
500	500,000	37	0.1162	0.813	0.519	0.0216	0.0222	0.0354
600	600,000	61	0.0992	0.893	0.626	0.0180	0.0187	0.0295
700	700,000	61	0.1071	0.964	0.730	0.0154	0.0159	0.0253
750	750,000	61	0.1109	0.998	0.782	0.0144	0.0148	0.0236

In order to apply the de-rating factor, Factor A, determine any difference between the cross-sectional area of the cable size assigned to the breaker or switch current rating shown in the Wire Size by Amp Rating table in this section and the cross-sectional area of the cable used in the installation. Then select the appropriate cable sizing selection factor from the table below:

Percentage of Rated Cross-Sectional Area	Derating Factor
50	1.40
60	1.25
70	1.15
80	1.07
90	1.02
100	1.00
125	0.99
150	0.97
200	0.97

Ambient Temperature – Factor B

Ambient temperature has a wider effect on the rating of the circuit breaker / cable system than making an exact match of the actual versus rated cable sizes. The term “ambient” temperature always refers to the temperature of the air immediately surrounding the protective device itself, not the temperature outside the device’s enclosure.

FB and FC breakers are “Enclosure Compensated” and, as such, their time-current curves reflect performance at an ambient of 40°C. Included on each curve is a key in the upper left corner that indicates how the x-axis of the curve should be shifted for ambients ranging from 0° to 60°C.

FE and FG breakers are equipped with electronic trip units and are not affected by ambient temperatures. There are, however, factors that should be applied to protect the devices from temperatures that could be potentially harmful to operators or to materials inside the circuit breaker.

Once the ambient temperature is determined, select the ambient temperature factor from the table below. It is important to note that the table below assumes that 90°C rated wire, sized according to the 75°C table, will be used for ambients above 40°C.

Factor B

Ambient Temperature (°C)	FB/FC	FE	FG
25	1.00	1.00	1.00
40	1.00	1.00	1.00
50	1.04	1.09	1.10
60	1.11	1.18	1.21
70	1.33	1.34	1.38

Altitude – Factor C

Record Plus breakers do not require any derating for altitudes below 6,000 feet. Reduced air density at altitudes above this affect the heat transfer out of the breaker. Use the table below to determine the necessary derating factor related to the installation altitude.

Installation Altitude		Derating Factor
Feet	Meters	
-100 - 6000	-30 - 1800	1.00
6001 - 10000	1801 - 3000	1.04
10000 +	3000 +	1.08

Load Class – Factor D

The table below lists six different load class factors. A specific load may involve more than one of these factors. For example, a group mounted circuit breaker may be protecting a circuit that includes a normal duty motor branch circuit. In this case, one would multiply the derating factor for group mounting by the derating factor for normal duty single motor branch circuit protection ($1.10 \times 1.25 = 1.375$). 1.375 would be the appropriate derating factor due to the load class.

Load Type	Derating Factor
Group Mounted (12 or more breakers)	1.10
Switching Capacitors	1.50
Switching Electromagnets	1.50
Single Motor Branch Circuit Protection (Normal Duty)	1.25
Single Motor Branch Circuit Protection (Heavy Duty)	1.75
All other Load Types (Normal Duty)	1.00

Safety Factor – Factor E

Safety factor is used to provide a design margin between the rating limit of a circuit breaker and the derived operating current calculated using all of the selection factors described in the derating equation.

A factor of safety of 10% is recommended to prevent nuisance tripping.

Intermittent / Continuous Duty Rating – Factor F

In those applications governed by UL rules and the National Electrical Code (NEC), an additional rating factor is necessary for standard-rated circuit breakers. This factor differentiates between continuous and intermittent duty.

When a circuit breaker is installed in an intermittent duty application, the duty rating factor is 1.00. Intermittent duty is defined as operation under rated load for a period of not more than three hours, followed by a period of no-load operation, followed by a period of rest. The time periods of no load and rest are undefined by the NEC. Some authorities suggest that the use of a three-hour period of no-load operation after the three-hour, full-load operation meets the intent of the term “intermittent.”

Continuous duty generally means operation without any time limit whatsoever, however, for purposes of rated molded-case circuit breakers, operation at rated loads for periods of time in excess of three hours is considered continuous duty. The duty rating factor for Record Plus breakers, as standard rated devices, in continuous duty application is 1.25.

Load Type	Derating Factor
Continuous (operation at constant load for greater than three hours)	1.25
Intermittent (operation at constant load for 3 hours or less)	1.00

Nomenclature Guide

Breaker Catalog Number

Record Plus Family	Frame Size (Maximum Amps)	Interrupt Tier (kA @ 480VAC Shown)	Pole Construction	Rated Voltage	Trip Unit Type	Rated Amps*	Connection
F	B - 100	S - 25kA	1 - 1 Pole	4 - 480 VAC	TE - Thermal - Magnetic	015 - 100 (FB / FC)	R / R0 - Standard, No Lugs
	C - 100	V - 35kA	2 - 2 Pole	6 - 600 VAC	AA - SMR1 Electronic	100 - 600 (FE / FG)	R1 - Breaker with Line and Load Lugs
	E - 250	N - 65kA	3 - 3 Pole		KA - SMR2 Electronic		R2 - Breaker with Load Lugs
	G - 600	H - 100kA	32 - 2 Pole in 3-Pole Frame **		KZ - SMR2 Electronic with ZSI		R3 - Breaker with Line Lugs
		L - 150kA	20 - 2-Pole Molded Case Switch **		F0 - Molded Case Switch **		RV - Breaker with Line Side Terminals for GE type AD Lighting Panels and Load Lugs
		P - 200kA	30 - 3-Pole Molded Case Switch **				
		Y - 150kA MCS **					

* - Breaker Rating for FB / FC, CT Rating for FE / FG

** - Molded Case Switch only available in 60 and 100A FC Frames

Rating Plug Catalog Number

Record Plus Family	Frame Size (Maximum Amps)	Accessory Type	Adjustability	Pole Construction	CT Max Amps	Rated Amps
F	B - N/A No Plug Necessary	R - Rating Plug	P - SMR1 - Fixed, Non Adjustable	3 - SMR1 Trip Unit 3 or 2 Pole	B - 25 (FE)	0025 - 0250 (FE)
	C - N/A No Plug Necessary		M - SMR2 - Fixed, Non Adjustable	3 - SMR2 Trip Unit 3 Pole	D - 60 (FE)	0100 - 0600 (FG)
	E - 250		N - SMR2 Adjustable LT PU and Delay	2 - SMR2 Trip Unit 2 Pole	G - 125 (FE)	
	G - 600				H - 150 (FE)	

Note: This information is provided for interpreting product numbers (it should not be used to build catalog nummmbers).

SMR2 Expansion Modules (If Needed)

See page 7

Internal Accessories

See pages 10-11

Mounting Hardware and External Accessories

See pages 12-15

Instruction Sheet Index

FB100		
Breaker	Installation Instructions	DEH41073
Internal Accessories	Auxiliary Switch / Bell Alarm	DEH40324
	Shunt Trip / Undervoltage Release	DEH40363
External Accessories	Lugs	DEH40532
	Padlock	DEH40521
Equipment Kits	Plug-In Panelboard	DEH41123
	Bolt-On Panelboard	DEH41124
	Cover Kit Panelboard	DEH41125
FC100		
Breaker	Installation Instructions	DEH40463
Internal Accessories	Auxiliary Switch / Bell Alarm	DEH40324
	Shunt Trip / Undervoltage Release	DEH40363
External Accessories	Lugs	DEH40532
	FCNRN FCNRH TDM Style Handles	DEH40517
	Padlocking Devices	DEH40521
	Variable Depth (Shaft) Operator Accessories (Use w/ STDA Flange Handles)	DEH40534
	STDA Flange Handle Operators, Cable Mech FC/FE	DEH40912
	FCNRM2 FCNRM4 THCH45 FC Handles	DEH40913
	FCNRC FCNRCN FCNRCI TDR Style Handles	DEH40914
	Plug-In Bases	DEH40915
	Door Ring Interlock	DEH40919
	Motor Operators	DEH40920
	STDA Handles (Shaft)	GEH5314
	TDV1 Door Interlocking	GEH5322
	TDS1 Extended Drive Stud for STDA Shaft Operator	GEH5325
	Plug-In Panelboard	DEH40403
	Bolt-On Panelboard	DEH40424
	Cover Kit Panelboard	DEH40536
FE250		
Breaker	Installation Instructions	DEH40360
Internal Accessories	Shunt Trip / Undervoltage Release	DEH40259
	Auxiliary Switch / Bell Alarm	DEH40324
External Accessories	Lugs	DEH41054
	FAT Trip Unit Test Kit	DEH40358
	FENBM Cable Operator	DEH40912
	FE STDA (Shaft) Operating Mech	DEH41014
	FENRH FENRT Rotary Handles	DEH41025
	FENRM2 FEMRM4 TDM Handle	DEH41027
	FENRC / FENRCI TDR Handles	DEH41028
	Padlock	DEH41059
	STDA Handles (Shaft)	GEH5314
	TDV1 Door Interlocking	GEH5322
	TDS1 Extended Drive Stud for STDA Shaft Operator	GEH5325
Equipment Kits	Plug-In Panelboard	DEH40402
	Bolt-On Panelboard	DEH40425
	Cover Kit Panelboard	DEH41271

FG600		
Breaker	Installation Instructions	DEH41177
Internal Accessories	Shunt Trip / Undervoltage Release	DEH40259
	Auxiliary Switch / Bell Alarm	DEH40324
External Accessories	Padlock	DEH41031
	FAT Trip Unit Test Kit	DEH40358
	Lug Kits	DEH40404
SMR2	SMR2 Expansion Modules	DEH40408
	SMR2 Modbus User Manual	DEH41181
	SMR2 External Contact Module	DEH40409
Equipment Kits	Plug-In Panelboard Single Branch	DEH40420
	Plug-in Panelboard Double Branch	DEH40419
	Bolt-On Panelboard Single Branch	DEH40426
	Bolt-On Panelboard Double Branch	DEH41047
	Cover Kit Panelboard	DEH41074

Information provided is subject to change without notice. Please verify all details with GE. All values are design or typical values when measured under laboratory conditions, and GE makes no warranty or guarantee, express or implied, that such performance will be obtained under end-use conditions.

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27 kV POWER/VAC® BREAKERS

and Available OEM Frame Elements

**27 kV, 16 & 25 kA, 125 kV Bil,
1200A & 2000A**



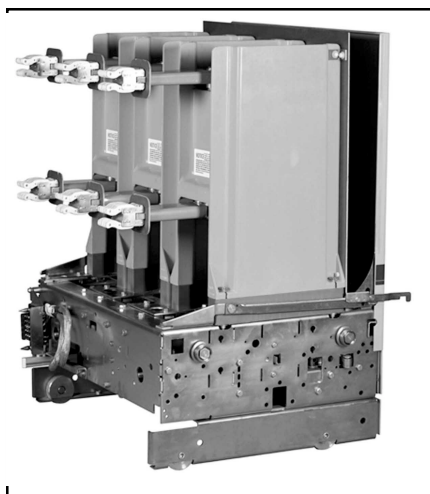
***From the Pioneers of
Vacuum Interruption
Technology. . .***

***27 kV POWER/VAC®
Breaker that is. . .***

- ***Designed and
based on customer
input***
- ***Loaded with new
features***
- ***Perfect for today's
climbing power
density***

***Satisfy all of your
breaker needs with
one source!***

Type VBB POWER/VAC® Vacuum Circuit Breaker



Breaker (rear view)

STANDARD BREAKER FEATURES

- **11-GAUGE FRONT PANEL** provides for a rugged flat front cover on the breaker. Once installed into the box frame, complete isolation is obtained between the secondary and primary compartments, ensuring operator protection from live parts.
- **PRIMARY DISCONNECT FINGERS** consist of silver plated copper tested for continuous and momentary currents. These disconnects provide proper contact throughout the life of the gear for the critical primary disconnect function.
- **INTERRUPTER SUPPORTS** are a rugged high strength, track-resistant polyester glass support assembly which firmly positions and holds the interrupters and primary conductors while providing insulation to ground and between phases.
- **ML-20 BREAKER MECHANISM** utilizes a spring-charged, stored energy design that is mechanically and electrically trip-free and can be operated by dc control voltages of 48V, 125V, or 250V, or AC voltages of 120V or 240V.
- **ROLL-IN DESIGN** of the breaker allows insertion of the breaker into the box frame without the need for a lift truck.

ANSI C37.06, C37.09, C37.54, C37.55, CSA Approved, UL Listed

NEW FEATURES!

27kV POWER/VAC® Breaker



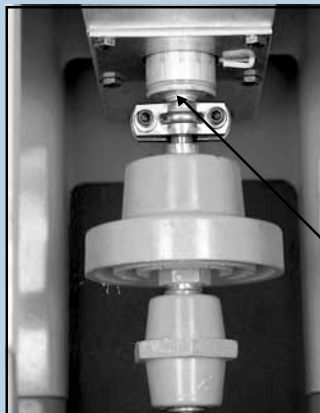
Second motor cut-off switch on negative interlock to prevent premature charge of motor



Increased motor life through improved performance of charging system

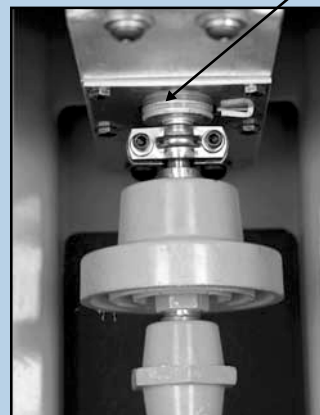


Insulation provided on breaker runbacks as standard



Open Position

Erosion indicator relocated to vacuum bottle



Closed Position

Increased stroke on all phases! Increased opening speed!

Many other mechanical design changes to improve performance, reliability with less maintenance!

POWER/VAC® Box Frame Elements

Power/Vac® 27kV Breaker Ratings 27 kV, 16 & 25 kA, 125 kV Bil, 1200A & 2000A

Available 27 kV Circuit Breaker Ratings as per ANSI C 37.06

Rated Maximum Voltage kV, rms	Rated Voltage Range Factor, K	Rated Continuous Current Amperes, rms	Rated Short Circuit and Short-Time Current kA, rms	Rated Transient Recovery Voltage		Interrupting Time Cycles	Rated Permissible Tripping Delay Time Y sec	Rated Closing and Latching Current kA peak
				Rated Peak Voltage E ₂ kV, Peak	Rated Time to Peak T ₂ micro sec			
27.0	1.0	1200	16.0	51.0	105	5	2.0	42.0
27.0	1.0	2000	16.0	51.0	105	5	2.0	42.0
27.0	1.0	1200	25.0	51.0	105	5	2.0	65.0
27.0	1.0	2000	25.0	51.0	105	5	2.0	65.0

Control Voltage and Operating Currents for ML-20 Mechanism

Control Voltage Source	Closing Range	Tripping Range	Closing Coil Current		Tripping Coil Current	Motor Inrush Current	Motor Windup Current	Fuse Size Close CKT Protection	
			W/O FBT	With FBT	5 Cycle			W/O FBT	With FBT
48 VDC	38-56	28-56	13.7	-	17.0	34	17.0	30	-
125 VDC	100-140	70-140	6.0	35.7	5.9	23	8.0	20	30
250 VDC	200-280	140-280	2.4	12.0	4.7	18	3.8	15	20
120 VAC	104-127	295-360 VDC ⁴	6.0	-	3.7	35	15.0	20	-
240 VAC	208-254	295-360 VDC ⁴	2.4	-	3.7	20	6.0	20	30

Notes

1. Approximate Spring Charge Time for ML-20 = 4 sec.
2. Fuses for tripping circuit should have ampere rating of at least 2 times the tripping current and not less than 35 amperes.
Tripping Circuit Fuse is 35A except for 240 VAC with Capacitor Trip - Use 10A.
3. FBT is fast bus transfer.
4. Capacitor trip, 120/240 VAC requires the capacitor trip to operate a 340 VDC trip coil.

27 kV List Price Structure

Breaker Type	Rating	Amperage	KA	GE List Price
VB-27-16-1200	27 kv	1200a	16	\$19,900.00
VB-27-16-2000	27 kv	2000a	16	\$24,500.00
VB-27-25-1200	27 kv	1200a	25	\$26,100.00
VB-27-25-2000	27 kv	2000a	25	\$29,900.00

Box Frame List Price Structure

Box Frame	Rating	Amperage	GE List Price
1200a	27 kv	1200a	\$5,900.00
2000a	27 kv	2000a	\$7,100.00



Breaker With Box Frame



Box Frame Rear View

FEATURES:

- Grounded metal shutter mechanism to cover primary connections when breaker is racked out.
- Primary barrier is furnished in front of shutters.
- Racking mechanism for the breaker includes interlocks, key locking and padlocking capabilities.
- Ground shoe for breaker.
- Provision for stationary auxiliary switch (max. 10A, 10B contacts) and breaker position switch (max. 6A, 6B contacts).

Options

Box frame options

- Blank
- 1200 amp breaker compartment
- 2000 amp breaker compartment
- With or without front door

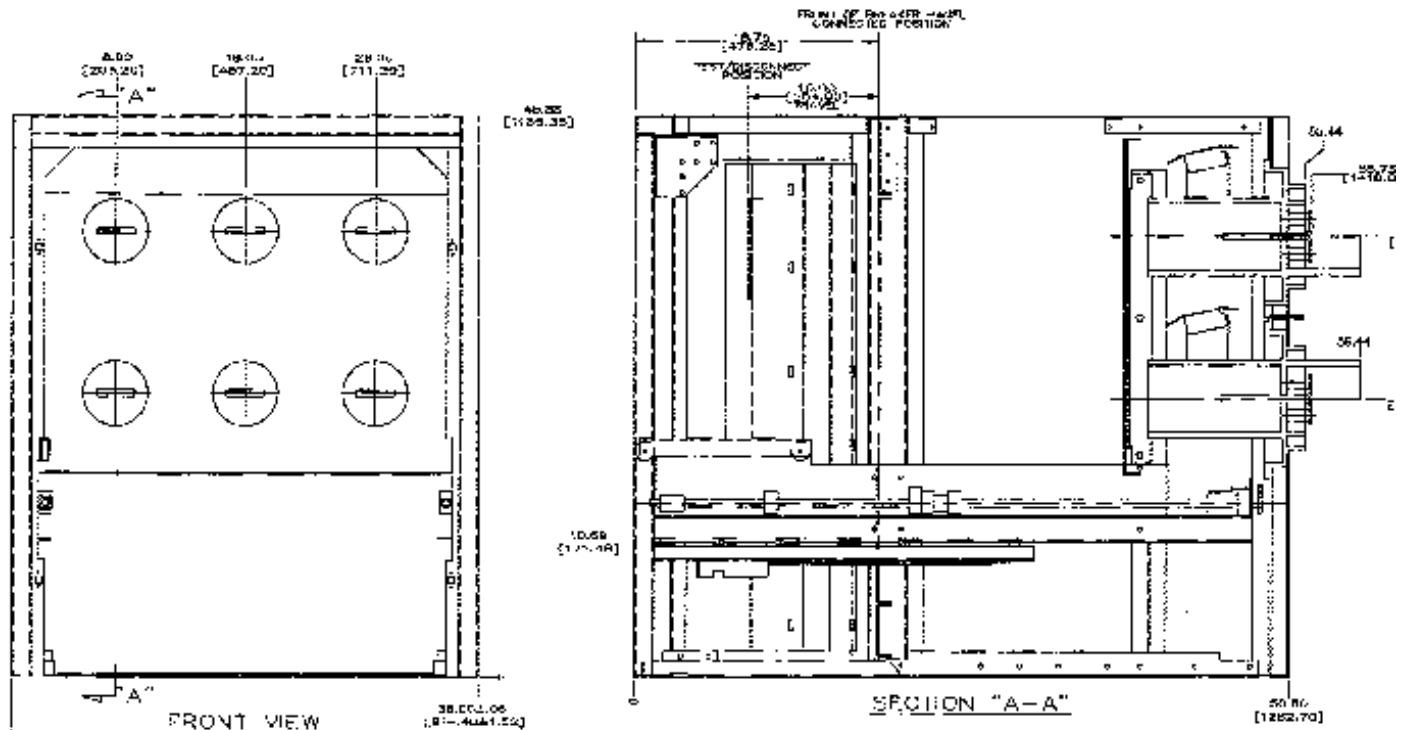
Box Frame assembled options

- Stationary auxiliary switch 3, 6, or 10 stage
- Position switch 3 or 6 stage

Accessories

- Test cabinet
- Manual racking handle
- Remote racking operator
- AC capacitor trip device
- Direct acting undervoltage for Vacuum breakers
- Breaker certified production test reports
- Primary boots

Box Frame Dimensions



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Power/Vac® 28kV Outdoor Vacuum Distribution Circuit Breaker

GE ED&C Switchgear Operation introduces the Power/Vac 28kV vacuum distribution breaker, an addition to the proven 15.5kV vacuum distribution breaker product line.

Applications:

Utility substations for distribution feeder protection and control

Capacitor bank switching

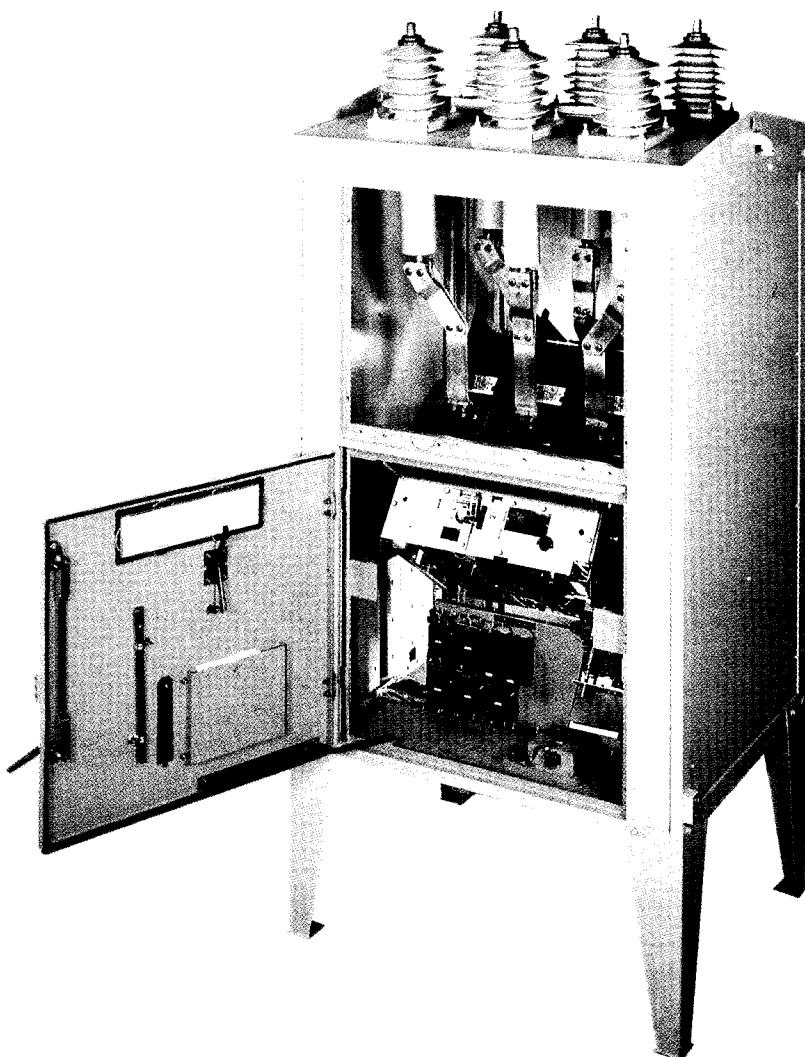
Reactor switching

Bus tie breaker protection

Overcurrent protection of transformers

Load distribution and reclosing applications

Industrial sites for main breaker requirements



GE Electrical Distribution & Control

GE Electrical Distribution & Control Power/Vac® 28kV Outdoor Vacuum Distribution Circuit Breaker

Product Description

- 28kV, 1200A and 2000A
- Standard porcelain bushings (epoxy optional) — 125kV B.I.L. and 150kV B.I.L.
- Includes space for up to two sets of double accuracy CT's per bushing, swing-out panel, and optional undervoltage trip device
- Spring-charged, stored energy ML-18 mechanism
- Built to current applicable ANSI, NEMA and IEEE standards

Benefits

COMPACT DESIGN

Rugged, lightweight construction is only 11 inches wider than the GE 15.5kV vacuum distribution breaker (unit height may vary depending on bushing type and breaker legs).

REDUCED MAINTENANCE

GE vacuum interrupters require minimum maintenance and servicing due to the absence of oil or SF₆ as an insulating and interrupting medium. Electrical contact maintenance is eliminated because the high vacuum environment isolates the contacts from exposure to dirt, moisture and other pollutants.

SAFETY

Used instead of oil as the primary insulation medium, hermetically sealed vacuum bottles significantly reduce the risk of fire or explosion.

DUTY CYCLE

No derating of interrupting capability is required regardless of the reclosing duty cycle.

LONG SERVICE LIFE

The breaker experiences no significant contact erosion during normal duty. It is designed and tested to meet or exceed performance requirements of applicable ANSI, NEMA and IEEE standards.

INSTALLATION COSTS

The breaker is shipped completely assembled — breaker legs are quickly bolted on during installation.

OPTIONAL OVERCURRENT PROTECTION

Designed to accommodate all control protection and indication functions.

OPTIONAL STAINLESS STEEL CONSTRUCTION

Offers excellent corrosion and exposure protection.

Technical Data

Breaker Type	PVDB-2
Rated Maximum Voltage	28kV
Nominal Voltage	25.8kV
Voltage Range Factor (K)	1.0
Frequency	60Hz
Low Frequency Withstand	
60Hz dry for 1 minute	60kV
60Hz wet for 10 seconds	50kV
Fullwave Withstand — B.I.L.	125kV and 150kV
Continuous Current Rating @ 60Hz	1200A , 2000A
Standard Duty Cycle	0 + 0sec + CO + 15sec + CO
Interrupting Time	5 Cycles (3 Cycles Optional)
Closing Time	5 Cycles
Rated Short Circuit Current (RMS)	12.5kA, 20kA, 25kA
Close and Latch Rating	
RMS Asymmetrical Peak	20kA, 32kA, 40kA 34kA, 54kA, 68kA
2-Second Short Time Current Rating (RMS)	12.5kA, 20kA, 25kA
Reclosing Time	20 Cycles
Permissible Tripping Delay	2 Seconds
Capacitance Current Switching	
General Purpose Duty	
Line Charging Current	5A
Isolated Cable Charging Current	160A
Isolated Capacitor Bank Rating	160A
Transient Recovery Voltage Peak	52kV
Time to Crest of Transient Recovery Voltage	52 microseconds
Number of Operations	
Load Current Switching	2500 Before Servicing
Full Fault Current Switching	15 Before Servicing
Control Voltages	DC: 48V, 125V, 250V AC: 120V, 240V (60Hz)



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